Sandia National Laboratories/New Mexico

PROPOSAL FOR RISK-BASED CONFIRMATORY SAMPLING NO FURTHER ACTION ENVIRONMENTAL RESTORATION SITE 18 CONCRETE PAD, TECHNICAL AREAS II AND V OPERABLE UNIT 1306

August 1997

Environmental
Restoration
Project

United States Department of Energy
Albuquerque Operations Office

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Prepared for the
U.S. Department of Energy

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LIST OF ACRONYMS

amsl	above mean sea level
bgs	below ground surface
CEARP	Comprehensive Environmental Assessment and Response Program
Co-60	cobalt-60
COC	constituents of concern
DOE-OB	DOE Oversight Bureau
DOU	Document of Understanding
DU	depleted uranium
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
ES&H	Environmental Safety and Health
ft	foot (feet)
HE	high explosives
KAFB	Kirtland Air Force Base
MDL	method detection limits
mg/kg	milligram(s) per kilogram
mg/L	milligram(s) per liter
mrem	millirem(s)/per year
MS/MSD	matrix spike/matrix spike duplicate
NFA	No Further Action
NMED	New Mexico Environment Department
NMUSTR	New Mexico Underground Storage Tank Regulations
OU	Operable Unit
PCB	polychlorinated biphenyl(s)
pCi/g	picocurie(s) per gram
ppm	part(s) per million
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	Resource Conservation and Recovery Act Facility Investigation
SNL/NM	Sandia National Laboratories/New Mexico
TA-III	Technical Area III
TEDE	total effective dose equivalent
TPH	total petroleum hydrocarbon(s)
UTL	upper tolerance limits
VCM	Voluntary Corrective Measure
XRF	X-ray fluorescence

1.0 INTRODUCTION

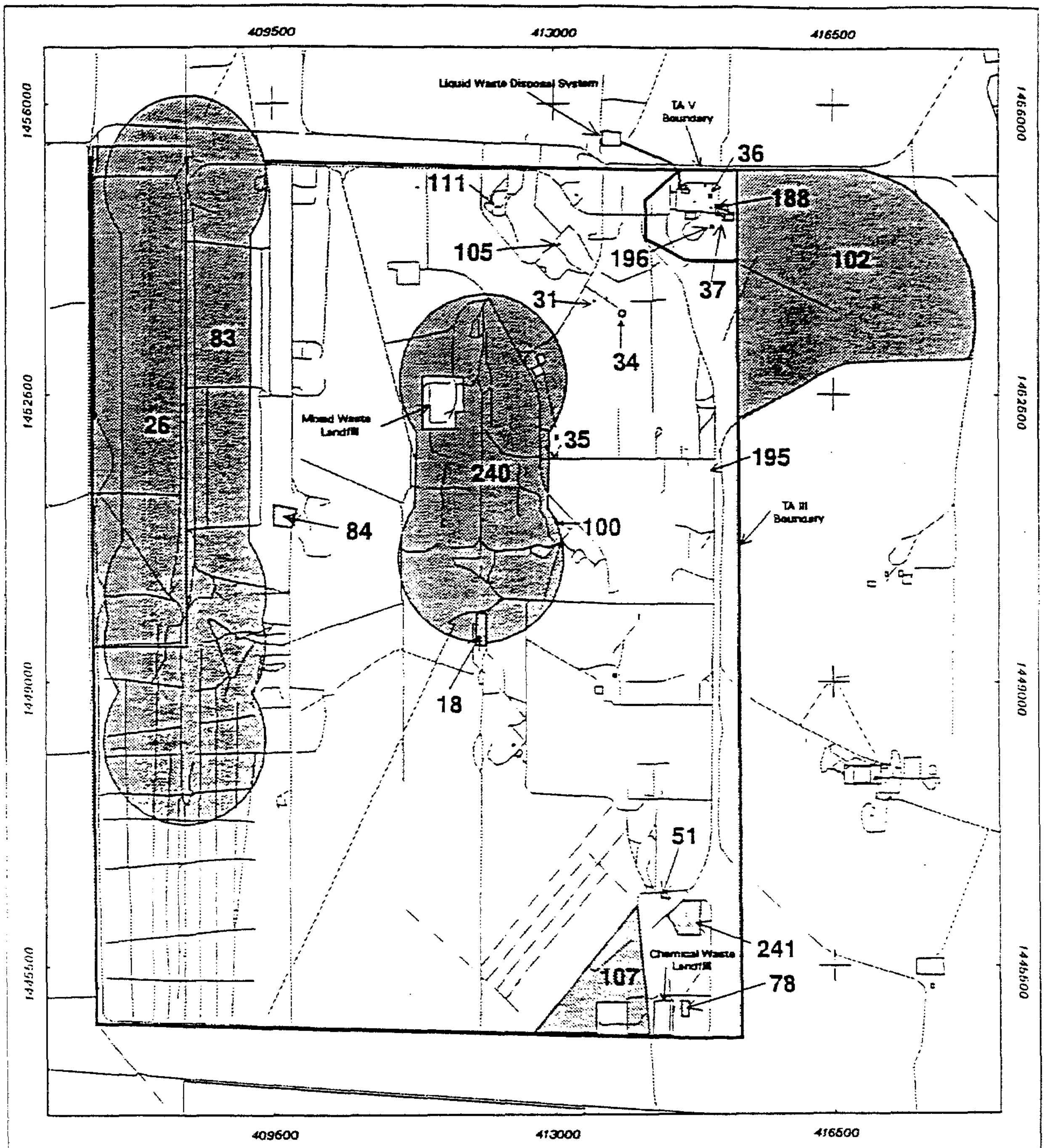
Environmental Restoration (ER) Site 18, the Concrete Pad, is located in Technical Area III (TA-III) at Sandia National Laboratories, Albuquerque, New Mexico (SNL/NM). The site was initially investigated as part of the Operable Unit (OU) 1306 TA-III/V Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI). Details of the investigation are included in the TA-III/V RFI Report (SNL/NM June 1996) submitted to the New Mexico Environment Department (NMED) and U.S. Environmental Protection Agency (EPA) in June 1996. Only a short summary of the investigation of Site 18 is provided in this proposal; the reader is referred to the RFI Report for additional details. During the course of the investigation, it was determined that concentrations of polychlorinated biphenyls (PCBs) in soil exceeded the cleanup criterion of 10 milligrams per kilogram (mg/kg) determined for the site and discussed in the Voluntary Corrective Measure (VCM) Report (SNL/NM July 1997, attached to this proposal). Therefore, a VCM was performed to remove the PCB-impacted soil. Based on the results of soil samples collected subsequent to this cleanup, this site is being proposed for No Further Action (NFA). Following is a discussion of the basis for this proposal.

1.1 Description of ER Site 18

The Concrete Pad is a 400-foot (ft) by 125-ft, 8-inch thick concrete surface located in central TA-III at the southern end of the Short Sled Track (ER Site 240, Figures 1-1 and 1-2). The site remains an active repository for test equipment for which the SNL/NM Environmental Safety and Health (ES&H) Manual requires environmental protection controls to ensure spills and contamination do not occur. Current and projected land use for Site 18 is industrial, based on the recommendations of the Albuquerque Citizens' Advisory Board (June 1996).

The site occupies approximately 1.1 acres and slopes gently to the west, at an average elevation of 5,387 ft above mean sea level (amsl). The area immediately adjacent to the pad is graded and clear of vegetation; however, the surrounding area is covered by vegetation, which consists predominantly of grasses, including grama, muhly, dropseed, and galleta. Shrubs associated with this grassland include sand sage, winter fat, saltbrush, and rabbitbush. Cacti are common, and include cholla, pincushion, strawberry, and prickly pear. The surficial geology at the site is characterized by a veneer of aeolian sediments underlain by alluvial fan deposits. Based on drilling records of similar deposits at Kirtland Air Force Base (KAFB), the alluvial materials are highly heterogeneous, composed primarily of medium to fine silty sands interbedded with frequent coarse sand, gravel, and cobbles.

The water-table elevation is approximately 4,930 ft amsl in the vicinity of Site 18. The depth to groundwater is approximately 460 ft below ground surface (bgs). The groundwater flow direction beneath the site is generally west to northwest. The nearest production well is KAFB-1903, located 6.5 miles to the southeast. The nearest groundwater monitor wells are located at the Mixed Waste Landfill in central TA-III, approximately 0.5 mile north of Site 18 (SNL/NM March 1995).



Sandia National Laboratories, New Mexico
Environmental Restoration Geographic Information System

Figure 1-1
Locations of OU 1306 ER Sites

Legend

TA-III/V ER Sites

Technical Area Boundary

Roads

Buildings, Elevation Contours and Drainages not shown.

0 1000 2000
Scale in Feet

0 240 480
Scale in Meters

Unclassified

FINAL

1:24000

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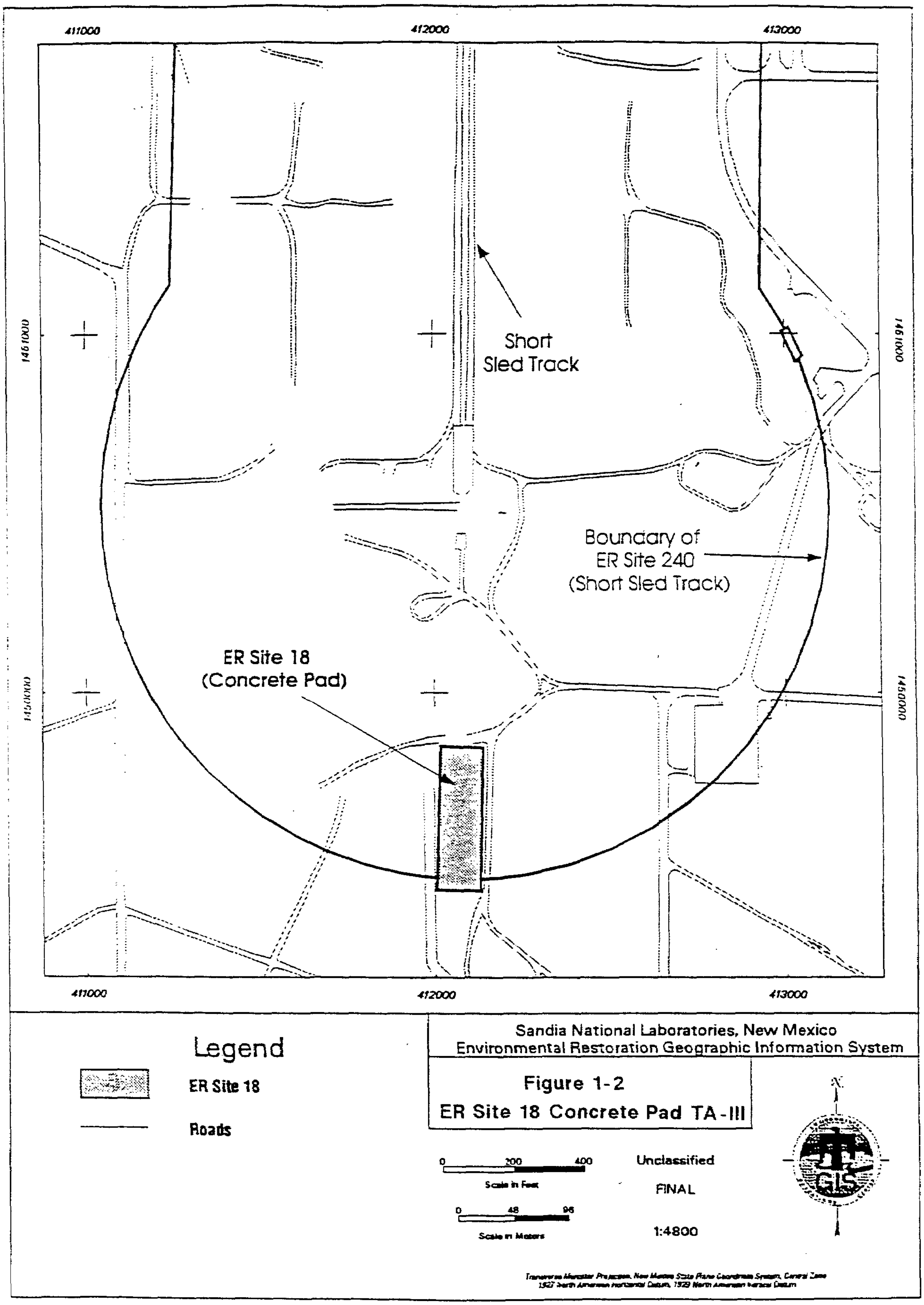


Figure 1-2
ER Site 18 Concrete Pad TA-III

Mapid=950911 11/14/95 SNL GIS ORG. cheberl rif18_31.aml

For a detailed discussion of the local setting and other information pertaining to ER Site 18, refer to the TA-III/V RFI Report (SNL/NM June 1996) and RFI Work Plan (SNL/NM March 1993).

1.2 No Further Action Basis

Review and analysis of all relevant data for ER Site 18 indicate that the constituents of concern (COC) at this site are below the sitewide background levels or the risk-assessment-derived action levels. As indicated in the RFI Report (SNL/NM June 1996), the results of sampling for metals indicated most were below site-specific or SNL/NM sitewide background concentrations, and the remainder were below the corresponding Subpart S RCRA action level. The only COC that was found during the RFI to exceed its action level (10 parts per million [ppm]) was a single PCB (Aroclor 1254). The VCM conducted to remove soil containing PCBs above 10 ppm was successful, and no soil containing PCBs above the action level remains at the site. A risk assessment that examined the contribution to risk from both radioactive and non-radioactive COCs concluded that Site 18 poses no risk to human health. Thus, ER Site 18 is being proposed for a risk-based confirmatory sampling NFA decision because the site was "remediated...and the available data indicate that contaminants pose an acceptable level of risk under current and projected future land use" (NFA Criterion 5 of the ER Document of Understanding [DOU], NMED April 1996).

2.0 HISTORY OF ER SITE 18

2.1 Historical Operations

The Concrete Pad was constructed in 1979 (SNL/NM June 1996). The pad has been used to store transformers, capacitors, rocket motors, generators, and rocket fuel inhibitors from TA-III activities, primarily sled track experiments. Because of the nature of some sled track activities, equipment might have been contaminated with high explosives (HE) residue, cadmium, chromium, zinc and other metals, and depleted uranium (DU), and transformers might have leaked oil or PCBs onto the pad.

2.2 Previous Audits, Inspections, and Findings

ER Site 18 was identified during investigations conducted under the Comprehensive Environmental Assessment and Response Program (CEARP) (DOE September 1987) and the RCRA Facility Assessment (RFA) (EPA April 1987). The CEARP determined that there was not enough information to calculate a hazard ranking score for the site.

3.0 EVALUATION OF RELEVANT EVIDENCE

Following are discussions of the evidence presented in support of a decision of NFA for ER Site 18.

3.1 Unit Characteristics and Operating Practices

Current operating practices are similar in nature to historical operations. Test equipment continues to be stored on the Concrete Pad by various SNL/NM line organizations. Current operating practices under the SNL/NM ES&H Manual require environmental protection controls such as secondary containment to prevent spills and contamination.

3.2 Results of Sampling/Surveys

3.2.1 Summary of Prior Investigations

The following sources of information, presented in chronological order, were used to evaluate Site 18:

- Historical aerial photographs (1973 through 1990)
- Surface radiation anomaly survey and removal VCM (1994 - 1996)
- RFI sampling of surface soils conducted in April 1994
- RFI sampling of subsurface soils conducted in January 1995
- VCM removal of PCB-impacted soil and confirmatory sampling conducted in August 1996.

3.2.2 Aerial Photograph Analysis and Interpretation

Aerial photographs from 1973 to 1990 were assembled, digitized, and compared for changes in surface features during successive years at the Concrete Pad. A review of the photographs indicated the Concrete Pad was constructed in 1979, and material was stored on it from that point forward.

3.2.3 Surface Radiation Survey and VCM

Site 18 was surveyed during March 1994 as part of the ER Project-wide surface radiation survey and removal VCM. The survey consisted of approximately 2 acres and included the Concrete Pad and surrounding flat terrain, which is covered by low grasses and brush. The Site 18 radiation survey area abutted the survey area for the Short Sled Track (ER Site 240, Figure 3-1). A gamma scan survey was performed on 6-ft centers over the exterior surface area of the site (Figure 3-1). Only one anomaly (approximately 1.5 x 1.5 ft) was detected in the Site 18 survey and was removed in August 1994. Confirmation sampling and gamma spectroscopic analysis of the Site 18 anomaly conducted in August 1994, indicated residual cobalt-60 (Co-60) at a decay-corrected activity of 3.53 picocuries per gram (pCi/g). The anomaly was resampled in May 1996, and gamma spectroscopic analyses indicated a decrease in Co-60 activity to 0.9 pCi/g. A risk analysis of the area was conducted using the higher activity (3.53 pCi/g); these results are discussed in Section 3.4.

Several anomalies were found in the adjacent survey area for Site 240 (Figure 3-1). The anomalies detected adjacent to, and overlapping, the Concrete Pad that were found during the survey of Site 240 were removed in October 1994. Because of the extent of one of the anomalies on the west side of the pad, follow-up cleanup was conducted in May 1996. The majority of anomalies at the Short Sled Track were DU-related. However, two of the anomalies west of the pad exhibited residual Co-60 with a maximum activity of 1.1 pCi/g Co-60, below that detected in the anomaly found during the Site 18 survey. The radioactive anomalies adjacent to the pad are believed to be related to testing activities conducted at the Short Sled Track, rather than to storage of materials on the Concrete Pad.

3.2.4 Surface Soil Sampling

Surface soil sampling was completed in April 1994 in two phases (SNL/NM June 1996). Samples were collected initially from 42 locations (18-SS-01 through -42, Figure 3-2) for field screening of metals, PCBs, and HE. The samples were split in the field for PCB immunoassay field screening, for HE analysis by colorimetric field screening, and for metals by X-ray fluorescence (XRF). Off-site laboratory analysis was performed on those samples for which field screening results indicated the possible presence of PCBs, HE, and/or metals.

Based on the field screening results, 12 surface soil samples were collected from a depth interval of 0 to 0.5 ft for off-site laboratory analysis of total petroleum hydrocarbons (TPH, per EPA Method 418.1), PCBs (per EPA Method 8080), metals (including total uranium, EPA Methods 6010/7000), HE (EPA Method 8330), and for on-site gamma spectroscopy analysis (Table 3-1). In addition, three samples were analyzed off site for isotopic uranium based on the results of the total uranium analyses.

Concentrations of metals at the surface were generally within TA-III/V or SNL/NM sitewide background concentrations, except as noted below (Table 3-1). With respect to TA-III/V background levels, cadmium was elevated in five samples, chromium and nickel were elevated in one sample, copper and lead were elevated in two samples, and zinc was elevated in three

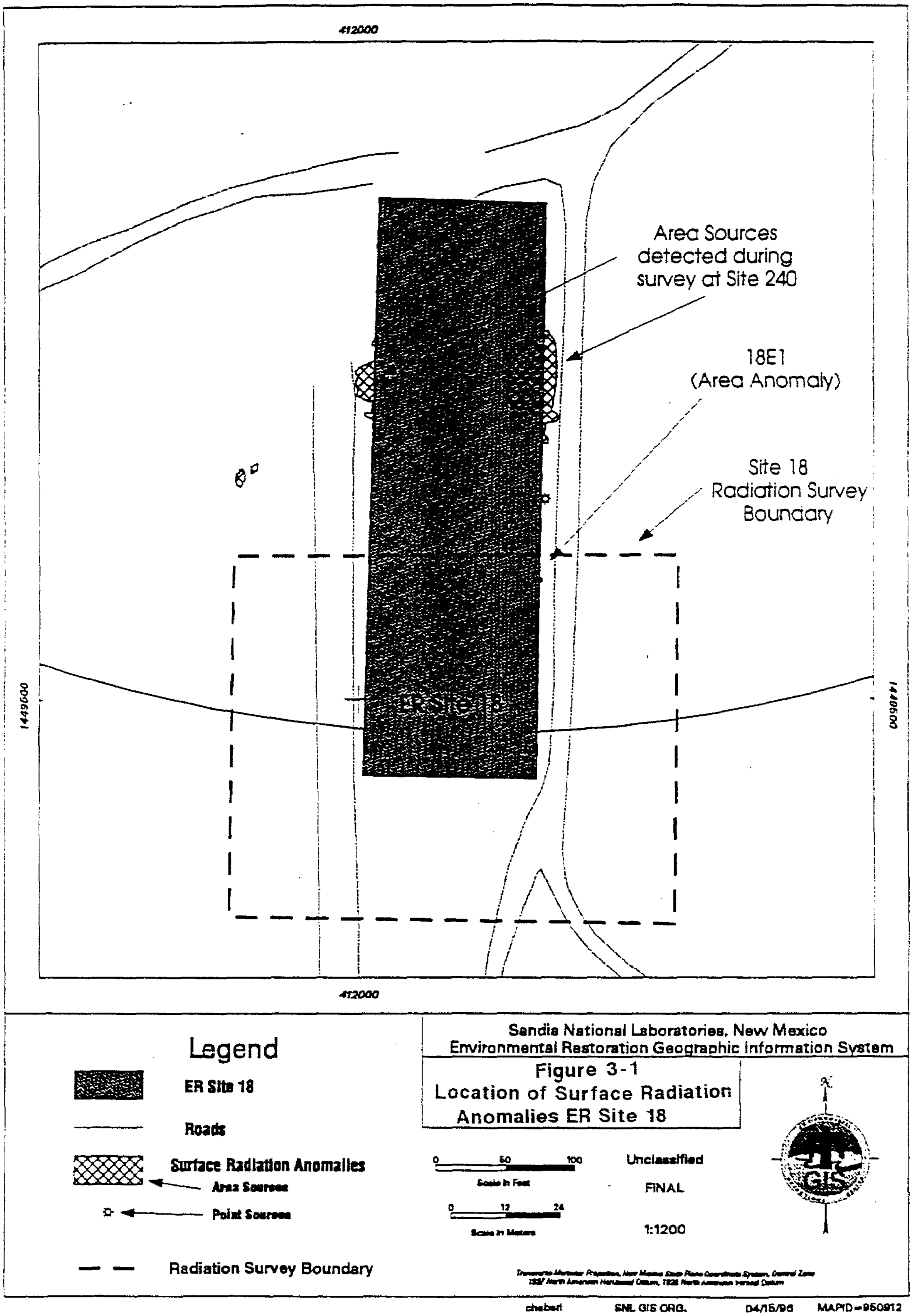
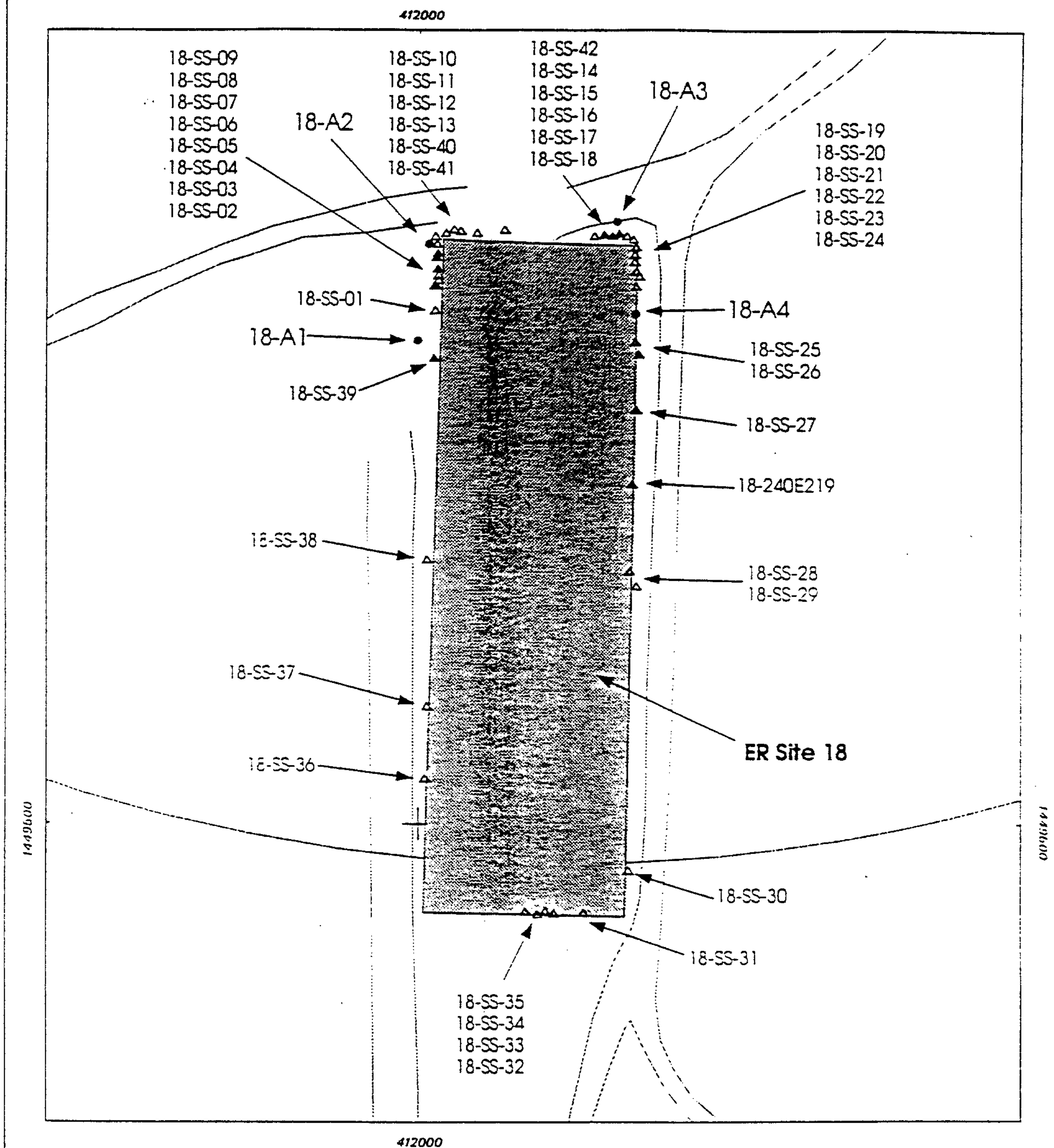


Figure 3-1
Location of Surface Radiation Anomalies ER Site 18



Legend

ER Site 18

Roads

18-SS-01 Field Screened Sample

18-SS-02 Off-Site Lab Sample

18-A1 Soil Boring

Sandia National Laboratories, New Mexico
Environmental Restoration Geographic Information System

Figure 3-2
Location of Surface Soil Samples and Soil Borings - ER Site 18, TA-III

0 50 100
Scale in Feet

0 12 24
Scale in Meters

Unclassified

FINAL

1:1200

Transverse Mercator Projection, New Mexico State Plane Coordinate System, Central Zone
1927 North American Horizontal Datum, 1929 North American Vertical Datum

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Table 3-1
Summary of ER Site 18 RFI Surface Soil Sample Analytical Results
April 1994

Sample Attributes			Metals (EPA 6010/7000) (mg/kg)											Organics (mg/kg)	
Sample Number	ER Sample ID (Figure 3-1)	Sample Depth (ft)	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	U	Zn	Aroclor 1254 (EPA 8080)	TPH (EPA 418.1)
015306	TA3/5-18-240E219	0-0.5	2.9	74.5	0.42	ND	6.2	8.7	ND	6	8.5	0.38	70	NA	ND
015616	TA3/5-18-SS-02	0-0.5	3.1	123	0.37	0.79	6.6	10.1	0.066J	7.1	16.5	0.86	34.3	36	32.8
015315	TA3/5-18-SS-06	0-0.5	2.3	66.6	0.37	2.7	12	29.5	0.11	6.2	34.3	0.60	51.1	0.78	ND
015313	TA3/5-18-SS-07	0-0.5	2.5	89.7	0.27	2.5	17.3	95.7	ND	9.5	60.4	0.77	63.2	1.6	29.2
015314	TA3/5-18-SS-08	0-0.5	2.6	72.3	0.37	0.89	66.5	12.8	ND	35.7	22.7	0.43	34.0	0.71	ND
015312	TA3/5-18-SS-14	0-0.5	2.8	94	0.42	15.2	5.4	7.6	ND	5.7	8.2	0.67	20.0	NA	20.9
015311	TA3/5-18-SS-14D	0-0.5	2.8	97.1	0.42	9.5	6.2	7.4	ND	6.7	7.8	0.80	21.1	NA	ND
015310	TA3/5-18-SS-15	0-0.5	3.1	99.2	0.58	17.5	7.4	7.3	ND	6.3	8.3	0.55	21.4	NA	ND
015309	TA3/5-18-SS-16	0-0.5	2.9	90.2	0.58	18.9	6.7	9.3	ND	6.7	9.9	0.62	24.1	NA	ND
015308	TA3/5-18-SS-26	0-0.5	3.2	82	0.74	ND	7.5	6.9	ND	7.4	6.9	0.52	22.4	NA	367
015307	TA3/5-18-SS-27	0-0.5	2.4	64.9	0.42	ND	6.7	7.4	ND	6.2	6.8	0.43	24.4	NA	ND
015305	TA3/5-18-SS-39	0-0.5	2.3	106	0.42	ND	6.6	9.3	ND	6.6	10.6	0.36	28.3	NA	2,250
	Practical Quantitation Limit (mg/kg)		1	1	0.2	0.5	1	2	0.1	4	0.3	0.0025	2	0.33	20
Surface Sample Quality Assurance/Quality Control Samples (in mg/L)															
015304	TA3/5-18-SS-FBA	NA	ND	ND	ND	ND	ND	ND	ND	ND	0.0042B	NA	0.012J	ND	ND
015303	TA3/5-18-SS-RBA	NA	ND	0.0045J	ND	ND	ND	0.016J	ND	ND	0.0042B	NA	0.029	ND	ND
	Practical Quantitation Limit (mg/L)		0.01	0.01	0.002	0.005	0.01	0.02	0.0002	0.04	0.003	NA	0.02	0.0001	1
	SNL/NM Site-Wide SNL Background UTL/95th% (mg/kg)		5.6	130	0.65	<1	17.3	15.4	<0.25	11.5	21.4	--	62	--	--
	TA-III/IV Background UTL/95th% (mg/kg)		--	341.0	0.7	2.6	26.2	14.5	--	12.9	24.8	--	41.8	--	--

Notes: **mg/kg** - Milligrams per kilogram; **mg/L** - milligrams per liter.
Metals: As - arsenic; Ba - barium; Be - beryllium; Cd - cadmium; Cr - chromium; Cu - copper; Hg - mercury; Ni - nickel; Pb - lead; Zn - zinc.
TPH - Total petroleum hydrocarbons.
J - Concentration below the practical quantitation limit (PQL); B - Analyte was detected in the laboratory method blank.
ND - Not detected at the method detection limit (MDL); UTL - upper tolerance limit.
NA - Not analyzed; -- - not applicable.
No site specific TA-III/IV background value calculated for As or Hg. SNL/NM site-wide background values for surface soils in "southwest group" used for comparison. Background levels for PCBs and TPH assumed to be 0.0 mg/kg.

samples. With respect to SNL site-wide background, arsenic, barium, and mercury were not elevated, beryllium was elevated in one sample, cadmium in six samples, copper in two, nickel in one, lead in three, and zinc was elevated in two samples. Total uranium concentrations were within the background ranges. Equilibrium evaluation of isotopic uranium activities indicated no elevated enriched uranium or DU.

HE were not detected above their method detection limits (MDLs). Concentrations of all but one PCB were below their MDLs; Aroclor-1254 ranged from 0.7 to 36 mg/kg. Only two samples exhibited TPH concentrations above 100 mg/kg (18-SS-26 contained 367 mg/kg TPH; 18-SS-39 contained 2,250 mg/kg TPH). Soil staining was not identified with elevated concentrations of any constituent, but it was noted that the majority of detected COCs were clustered around the northern end of the pad, at the northwest and northeast corners. These were the locations where dismantling of locomotives and transformer storage had occurred.

3.2.4.1 Quality Assurance/Quality Control Results

A field blank and a rinsate blank (both aqueous) were collected and analyzed for TPH, PCBs, metals, and HE. No TPH, PCBs, or HE were detected in either blank above the MDL. Barium, copper, and zinc were detected in concentrations below the practical quantitation limits (i.e., "J" values). The rinsate blank contained a minor amount of zinc (0.029 mg/kg) and both blanks contained low concentrations of lead (0.0042 milligrams per liter [mg/L]), but lead was also noted in the laboratory's method blank. None of these concentrations of metals indicated potential problems with any of the soil data. The matrix spike/matrix spike duplicate (MS/MSD) data indicated no problems with recovery of TPH or of the metals of interest. A duplicate soil sample was collected from location TA3/5-18-SS-14 and analyzed for TPH, metals, and HE. As is evident from Table 3-1, generally close correlation between the original sample and its duplicate was noted.

3.2.5 Subsurface Soil Sampling

In January 1995, four shallow auger holes (18-A1, 18-A2, 18-A3, and 18-A4) were drilled to a total depth of 6 ft in the areas identified during the surface soil sampling event as having elevated surface constituents (Figure 3-2). Soil samples were collected at 2-ft depth intervals (SNL/NM 1996) and the samples from the 2-ft and 6-ft depths were analyzed for those metals that were elevated in the surface soils (cadmium, chromium, copper, lead, and zinc) and for TPH to define the vertical extent of contamination. No cadmium was detected in any of these soil samples. None of the other metals exceeded SNL/NM sitewide background upper tolerance limits (UTL) or 95th percentiles (Table 3-2). Concentrations of TPH decreased within the first 2 to 6 ft bgs to less than the New Mexico Underground Storage Tank Regulations (NMUSTR) standard of 100 mg/kg (Table 3-2).

Table 3-2
Summary of Site 18 RFI Subsurface Soil Sample Analytical Results
January 1995

Sample Attributes			Metals (EPA 6010/7000) (mg/kg)					TPH (EPA 418.1) (mg/kg)
Sample Number	ER Sample ID	Sample Depth (ft)	Cd	Cr	Cu	Pb	Zn	TPH
021503	TA3/5-18-A1-2	2-2.5	ND	13.1	6.2	5.1	24.4	ND
021505	TA3/5-18-A1-6	6-6.5	ND	12.3	4.6	3.7J	21.1	39.2
021506	TA3/5-18-A2-2	2-2.5	ND	7.4	5.5	5.5	21.5	NA
021508	TA3/5-18-A2-6	6-6.5	ND	11.6	12.7	4.6J	21.5	NA
021511	TA3/5-18-A3-2	2-2.5	ND	6.4	3.2	3.9J	14.4	NA
021513	TA3/5-18-A3-6	6-6.5	ND	11.3	6.0	3.7J	26.3	NA
021514	TA3/5-18-A4-2	2-2.5	ND	7.5	4.8	3.3J	20.7	697
021516	TA3/5-18-A4-6	6-6.5	ND	6.4	4.7	3.3J	18 .7	ND
021517	TA3/5-18-A4-6D (duplicate sample)	6-6.5	ND	8.3	7.9	5.5	23.8	69.1
Practical Quantitation Limit (mg/kg)			0.5	1.0	2.0	5.0	2.0	20.0
Subsurface Sample Quality Assurance/Quality Control Samples (in mg/L)								
021510	TA3/5-A2-FBA	NA	ND	ND	0.0067J	ND	0.011J	ND
021509	TA3/5-A2-RBA	NA	ND	ND	0.0061J	ND	0.0062J	ND
Practical Quantitation Limit (mg/L)			0.005	0.01	0.02	0.05	0.02	1
SNL/NM Background UTL/95th% (mg/kg)			0.9	15.9	18.2	11.8	62	--

Notes: mg/kg - Milligrams per kilogram; **mg/L** - milligrams per liter.
Metals: **Cd** - cadmium; **Cr** - chromium; **Cu** - copper; **Pb** - lead; **Zn** - zinc. **TPH** - Total petroleum hydrocarbons.
J - Concentration below the practical quantitation limit (PQL).
ND - Not detected at the method detection limit (MDL); **UTL** - upper tolerance limit; **NA** - Not analyzed; **- -** - Not applicable.
No TA-III/IV site-specific background UTLs or 95th percentiles were calculated for subsurface soils. SNL/NM sitewide background values for subsurface soils in "southwest group" used for comparison.

3.2.5.1 *Quality Assurance/Quality Control Results*

As part of the subsurface investigation, a field blank and a rinsate blank (both aqueous) were collected and analyzed for TPH and metals (cadmium, chromium, copper, lead, and zinc). No TPH was detected, and only copper and lead were detected (in "J" concentrations) in the blanks. None of these concentrations of metals indicated potential problems with any of the soil data. The MS/MSD data indicated normal recovery of TPH and the metals of interest.

A duplicate soil sample was collected from location TA3/5-18-A4-6 and analyzed for TPH and metals. As indicated in Table 3-2, general correlation between the original sample and its duplicate was noted, except for TPH. The original sample contained no detectable TPH (at a detection limit of 20.0 mg/kg); its duplicate contained 69.1 mg/kg TPH, but this concentration is also below the NMUSTR standard of 100 mg/kg.

3.2.6 Voluntary Corrective Measure—Removal of PCB-Impacted Soil

A VCM was performed at the Concrete Pad in August 1996 to remove and dispose of soil containing PCBs near the northwest corner of the concrete pad. A more detailed description of VCM activities is provided in the VCM Report (Section 6.1). In accordance with EPA guidance (EPA 1996), and in consultation with NMED DOE Oversight Bureau (DOE-OB) personnel, a level of 10 mg/kg was chosen as an appropriate cleanup standard. A detailed discussion of the process used to arrive at this cleanup level is provided in the attached VCM Report (Section 6.1).

Immunoassay field screening was used to identify the area of PCB-impacted soil (Figure 3-3) and to verify that contaminated soil had been removed. The removed area was approximately 20-ft wide and 40-ft long (Figure 3-3) and was excavated to an average depth of 6 inches. Additional soil was removed to ensure a "clean" depth, as indicated by field screening (i.e., concentrations below 1 ppm). Eight confirmation soil samples were collected from the sides and bottom of the excavation (Figure 3-4) and were submitted for off-site laboratory analysis of PCBs in accordance with EPA Method 8080. A single sample (Sample 6 on Figure 3-4) was submitted for analysis of TPH per EPA Method 418.1. A summary of soil sample analytical results for the confirmation soil samples is provided in Table 3-3. None of the confirmation soil samples exceeded the cleanup level of 10 mg/kg PCBs; the sample analyzed for TPH showed no detectable TPH. After receipt of the analytical results, the area was backfilled with clean soil and returned to grade.

A comparison of elevated COCs with respect to RCRA Subpart S action levels is provided in Table 3-4. None of the maximum levels exceeded the corresponding Subpart S levels.

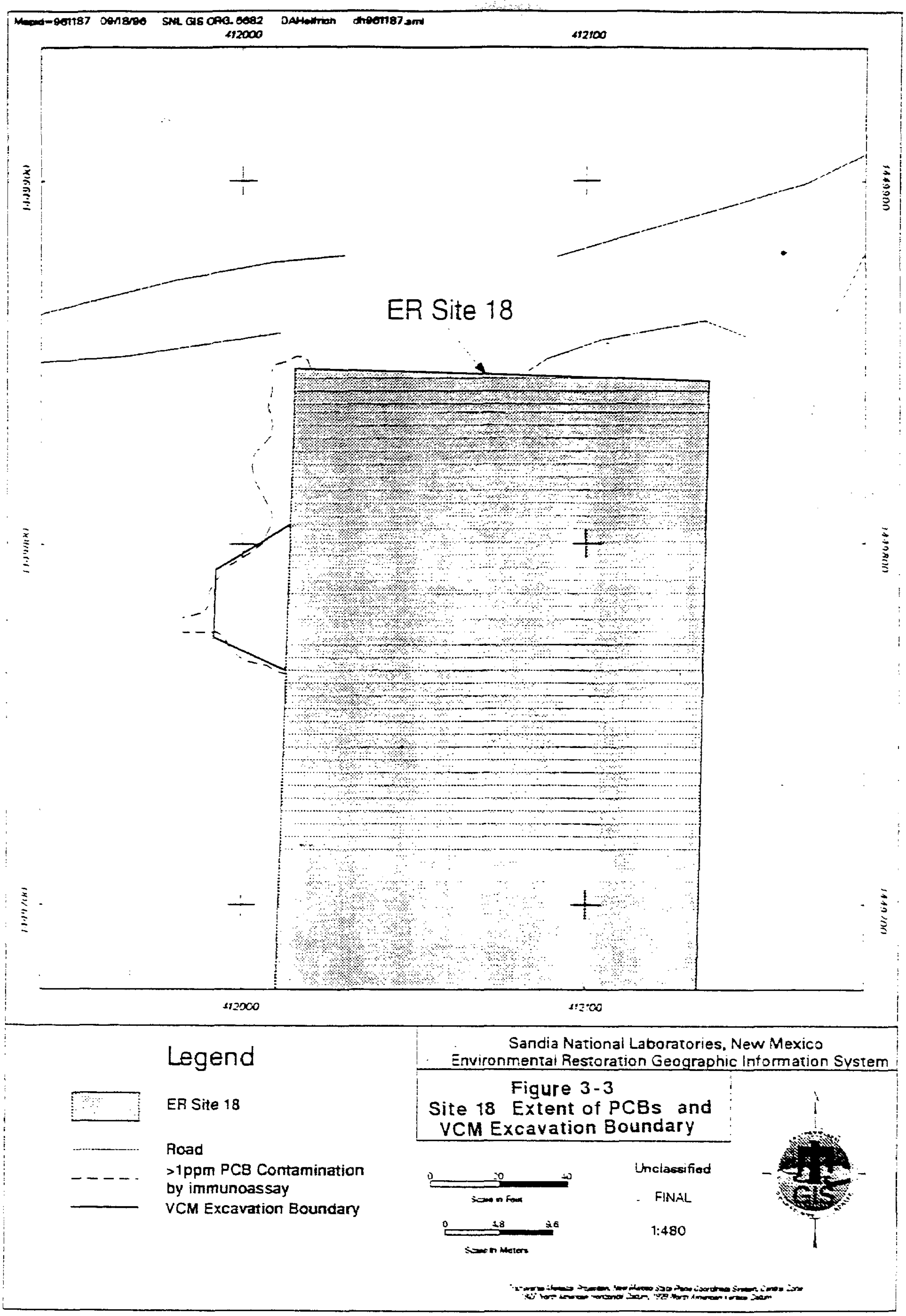
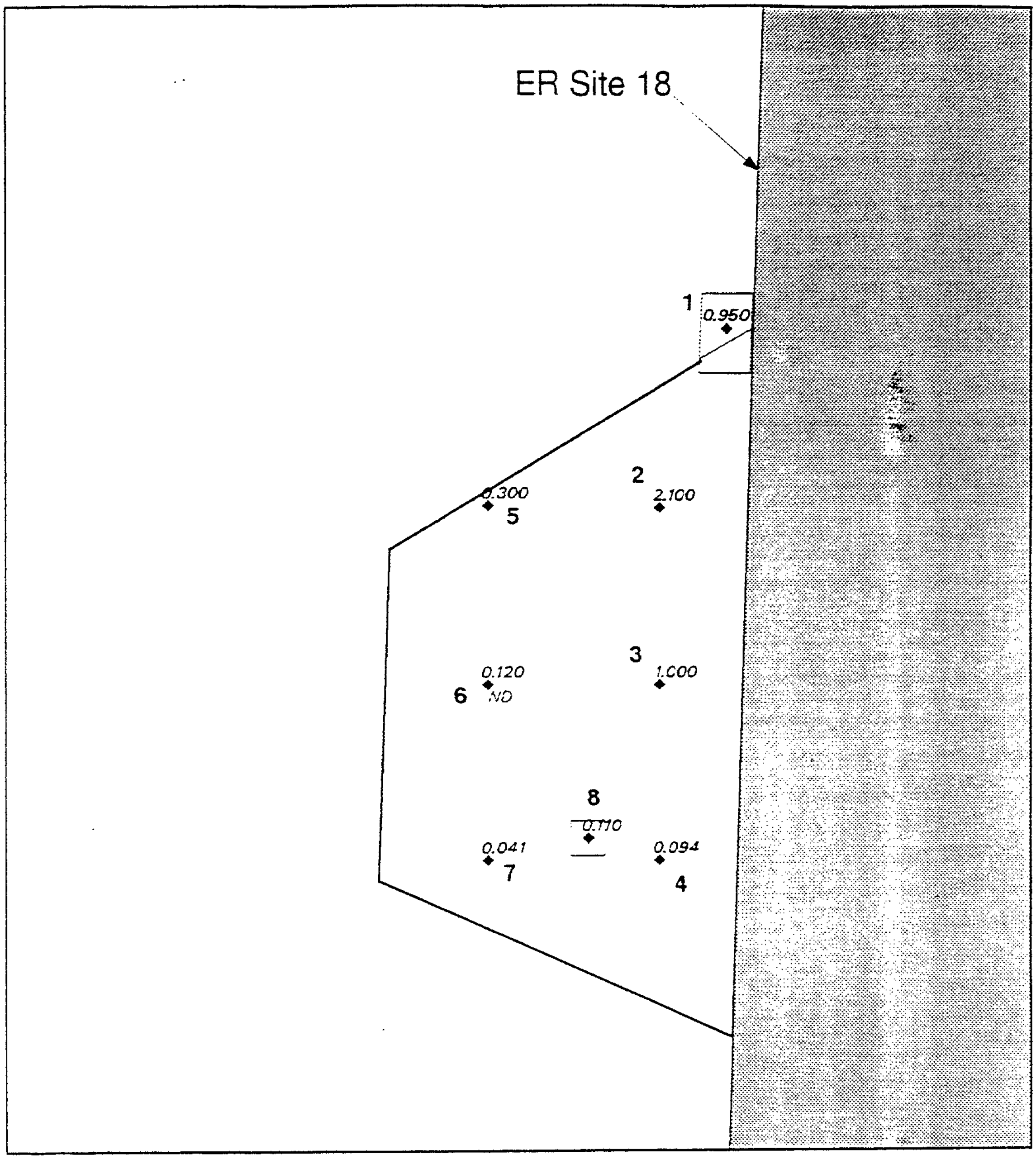


Figure 3-3
Site 18 Extent of PCBs and VCM Excavation Boundary

Mapid=961192 09/18/96 SNL GIS ORG. 6682 DAHelfrich dh961192.aml



Legend

ER Site 18

Primary Excavation Boundary

Secondary Excavation Boundary

1 0.950 Offsite Confirmatory Sample Location (#=ppm PCB)
ND=ppm TPH

Sandia National Laboratories, New Mexico
Environmental Restoration Geographic Information System

Figure 3-4 ER Site 18
Location of Post-VCM Confirmatory Soil Samples

0 5 10
Scale in Feet

0 1.2 2.4
Scale in Meters

Unclassified

FINAL

1:120

Transverse Mercator Projection, New Mexico State Plane Coordinate System, Central Zone
1927 North American Horizontal Datum, 1929 North American Vertical Datum

Table 3-3
Summary of Site 18 RFI Post-VCM Confirmatory
Soil Sample Analytical Results, August 1996

Sample Number	ER Sample ID	Sample Depth (ft)	Aroclor-1254 (mg/kg)	Aroclor-1254 Detection Limit (mg/kg)	TPH (mg/kg)
031021	TA3/5-18-D1-001	0 - 0.5	0.950	0.350	NA
031022	TA3/5-18-D1-002	0 - 0.5	2.100	0.340	NA
031023	TA3/5-18-D1-003	0 - 0.5	1.000	0.340	NA
031024	TA3/5-18-D1-004	0 - 0.5	0.094	0.034	NA
031025	TA3/5-18-D1-005	0 - 0.5	0.300	0.033	NA
031026	TA3/5-18-D1-006	0 - 0.5	0.120	0.033	ND<20
031027	TA3/5-18-D1-007	0 - 0.5	0.041	0.033	NA
031028	TA3/5-18-D1-008	0 - 0.5	0.110	0.034	NA
Risk-Based Action Level or Cleanup Level			10	--	100

Notes:

ft - feet
mg/kg - milligrams per kilogram
NA - Not analyzed
ND - Not detected at the method detection limit.
TPH - Total petroleum hydrocarbons.
-- - Not applicable

Table 3-4
Comparison of Site 18 Soil Analytical Results to Proposed
RCRA Subpart S Soil Action Levels

Parameter	Maximum Concentration at Site 18 (mg/kg)	Proposed RCRA Subpart S Soil Action Level (mg/kg)	Exceeds Proposed RCRA Subpart S Soil Action Level?
Aroclor-1254	2.3	10[a]	No
Cadmium	18.9	80	No
Chromium	66.5	400	No
Copper	95.7	NA[b]	NA
Lead	60.4	2,000	No
Nickel	35.7	2,000	No
Zinc	70	20,000	No

[a]Proposed (Spring 1996).
[b]Not applicable; no action level currently promulgated for this constituent.

3.2.6.1 *Quality Assurance/Quality Control Results*

A MS/MSD analysis conducted by the off-site laboratory for the batch of post-excavation confirmatory soil samples indicated recovery of PCBs within normal limits.

3.3 Gaps in Information

The original (i.e., pre-RFI) gaps in information for Site 18 include lack of reliable data on the actual uses of the site and the possible contaminants associated with them. The RFI focused on the distribution of contaminants adjacent to the Concrete Pad. The extent of metals, TPH, and PCBs was defined during the RFI, and the PCB- and TPH-impacted soils detected during the investigation were removed and disposed of during the VCM. Thus, the question of types and distribution of COCs at the Concrete Pad was answered during the RFI and subsequent VCM.

3.4 Risk Evaluation

A risk evaluation for the elevated COCs for Site 18 was conducted to determine the contribution of radionuclides, metals, and PCBs (i.e., that amount remaining upon the conclusion of the VCM) to total risk to human health. A complete discussion of the risk analysis is provided in Section 6.2. An ecological risk analysis was also conducted for Site 18 for all three ecological receptors. Section 6.3 presents the results of the ecological risk assessment. Findings of the risk analyses are summarized here.

3.4.1 Human Health Risk Analysis

Although ER Site 18 has been designated as industrial for a future land-use scenario, both industrial and residential scenario (the latter to provide perspective) risk analyses were conducted for surface soils where metals, PCBs, and radionuclides were elevated with respect to background. A complete discussion of both scenarios is provided in the risk assessment analysis in Section 6.2. For nonradiological compounds, the main contributors to the industrial land-use scenario risk assessment values were arsenic, beryllium, cadmium, and PCBs. Although arsenic was a contributor to risk, the maximum arsenic concentration was below the SNL background UTL value.

Using conservative assumptions and employing a Reasonable Maximum Exposure approach to the risk assessment, the calculations for the nonradiological COCs show that for the industrial land-use scenario the Hazard Index (0.06) is significantly less than the accepted numerical guidance (i.e., a value of 1) from the EPA (1989). The estimated cancer risk (1×10^{-5}) is in the middle of the suggested acceptable risk range of 1×10^{-4} to 1×10^{-6}. Incremental risk is determined by subtracting risk associated with background from potential nonradiological COC risk. The incremental Hazard Index is 0.04 and the incremental cancer risk is 5×10^{-6} for the industrial land-use scenario. Incremental risk calculations indicate insignificant risk from the nonradiological COCs considering an industrial land-use scenario.

The incremental total effective dose equivalent (TEDE) is less than EPA guidance values; the estimated incremental TEDE is 10.1 millirem (mrem)/year for the industrial land-use scenario. This value is less than the numerical guidance of 15 mrem/year in draft EPA guidance. The corresponding incremental estimated cancer risk value is 2×10^{-4} for the industrial land-use scenario.

The uncertainties associated with the risk analysis calculations are considered small relative to the conservatism of the risk assessment analysis. It is therefore concluded that Site 18 does not have significant potential to affect human health under an industrial land-use scenario.

3.4.2 Ecological Risk Analysis

Potential risks were indicated for all three ecological receptors at ER Site 18, however, the use of the maximum measured soil concentration to evaluate risk provided the "worst case" scenario for the risk assessment and may not reflect actual conditions. As an example, the only area along the Site 18 concrete pad where concentrations of PCBs were detected was within a 700 ft^2 area. This area covers approximately 1/20th of the perimeter around the pad. Based on the limited extent of contamination and the fact that the concrete pad itself does not contain significant ecological habitat, risk to wildlife receptors from PCB exposure at this site is expected to be minimal despite the fact that HQs greater than unity were predicted in the screening assessment. In a similar light, risk was also predicted for vegetation exposed to maximum concentrations of cadmium, chromium, lead, nickel, and zinc in soils from the site. Because the entire buffer zone around the concrete pad is less than half an acre and no sensitive plant species are expected to occur in the area, risk to plant populations and communities within the area is not expected to be significant.

Mercury in soil (0.11 mg/kg) produced a HQ of 1.57 for the owl. This mercury concentration is within the range of background soil concentration. No other chemicals were predicted to be of potential ecological risk at Site 18. The same was found true for Co-60 (6.75×10^{-4} rad/day, much less than 0.1 rad/day).

4.0 RATIONALE FOR NO FURTHER ACTION DECISION

ER Site 18 is being proposed for a determination of NFA based on the following information presented in the preceding sections of this proposal and in the RFI Report (SNL/NM June 1996):

- The RFI defined the extent of metals, TPH, PCBs, and radioactive constituents to be confined to the shallow subsurface;

- The distribution of radionuclides (i.e., DU and Co-60) is believed to be related to activities at the Short Sled Track (ER Site 240), rather than those associated with the Concrete Pad;

- The levels of COCs in the surface soils and shallow subsurface were demonstrated to be within either background levels (TA-III/IV or SNL/NM sitewide background) or risk-based action levels (e.g., PCB cleanup level of 10 mg/kg); and

- The soil impacted by PCBs and the area exhibiting the maximum TPH level was removed and disposed of during the VCM, and confirmatory soil samples indicated no soil remained that contained PCBs above the action level of 10 ppm or TPH above 100 ppm.

The NFA Criterion 5 of the DOU is applicable to Site 18, specifically that the site was "remediated...and the available data indicate that contaminants pose an acceptable level of risk under current and projected future land use" (NMED April 1996).

5.0 REFERENCES

DOE, September 1987. Phase I: Installation Assessment, Sandia National Laboratories - Albuquerque, Comprehensive Environmental Assessment and Response Program [Draft], (CEARP), U. S. Department of Energy, Albuquerque Operations Office, Albuquerque, New Mexico.

New Mexico Environment Department (NMED), April 1996. "Environmental Restoration Document of Understanding," agreement between New Mexico Environment Department, U.S. Environmental Protection Agency, U.S. Department of Energy, Los Alamos National Laboratories, and Sandia National Laboratories/New Mexico.

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6.0 ANNEXES

6.1 Site 18 Voluntary Corrective Measure Report

6.2 Site 18 Risk Assessment Analyses

Section 6.1
Site 18 Voluntary Corrective Measure Report

VOLUNTARY CORRECTIVE MEASURE REPORT
Environmental Restoration Project

Site 18, Concrete Pad - Removal of PCB-Impacted Soil
Technical Areas III and V
Operable Unit 1306
July 1997

Prepared by
Sandia National Laboratories/New Mexico
Environmental Restoration Project
Albuquerque, New Mexico

Prepared for the
United States Department of Energy

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Figure 2-2. ER Site 18 VCM - Location of Post-VCM Confirmatory Soil Samples

1.0 INTRODUCTION

ER Site 18, the Concrete Pad, is located in Technical Area III (TA-III) at Sandia National Laboratories, Albuquerque, New Mexico (SNL/NM). The site was initially investigated in 1994-1995 as part of the Operable Unit (OU) 1306 TA-III/V Resource Recovery and Conservation Act (RCRA) Facility Investigation (RFI). Details of the investigation are included in the TA-III/V RFI Report (SNL/NM June 1996) submitted to the New Mexico Environment Department (NMED) and U.S. Environmental Protection Agency (EPA) in June 1996. During the course of the investigation, it was determined that concentrations of polychlorinated biphenyls (PCBs) in soil exceeded the cleanup criterion. Therefore, a Voluntary Corrective Measure (VCM) was performed to remove the PCB-impacted soil. Based on the results of soil samples collected subsequent to this cleanup, this site is being proposed for a determination of No Further Action (NFA).

A request for temporary authorization to perform the VCM was submitted to the NMED in May 1996. Details of the planned activity were presented in the accompanying VCM Plan (SNL/NM May 1996) and were also presented at a public meeting in May 1996. The VCM was conducted in close consultation with NMED/Department of Energy Oversight Bureau (DOE-OB) personnel.

This VCM Report is attached as an annex to the Site 18 NFA Proposal; the reader is referred to the main text of the NFA Proposal (SNL/NM July 1997) as well as to the Site 18 VCM Plan (SNL/NM May 1996) and the original RFI Report (SNL/NM June 1996) for additional details.

2.0 VOLUNTARY CORRECTIVE MEASURE

A VCM was performed near the northwest corner of the Concrete Pad in August 1996 to remove and dispose of soil containing PCBs. The maximum level of PCBs (Aroclor 1254) detected during the RFI sampling was 36 milligrams per kilogram (mg/kg).

A discussion of the process used to arrive at a PCB cleanup level is presented in Section 2.1, exceptions to the VCM Plan are described in Section 2.2, and the results of the post-VCM verification sampling event are discussed in Section 2.3.

2.1 PCB Cleanup Levels

As indicated above, during RFI surface soil sampling, a maximum PCB concentration of 36 mg/kg was detected at the site near the northwest corner of the Concrete Pad. Cleanup of such levels is regulated based on the date of the spill. In a March 1996 memorandum sent from EPA Region VI to SNL/NM ER Project personnel, the controlling policies were defined as follow:

"...[For] spills [of PCBs] that occurred prior to April 18, 1978, the cleanup is covered under RCRA. For spills that occurred between April 18, 1978 and May 3, 1987, both TSCA [Toxic Substances Control Act] and RCRA apply. After May 3, 1987, the spill should [be] addressed under TSCA."

Accompanying the memorandum was an attachment labeled "EPA's Current Regulatory Perspective on the PCB Spill Cleanup Policy" by Dr. John H. Smith of the EPA and a set of handouts on the topic. Included in the handouts was a statement that read in part, "[Cleanup of] spills between April 18, 1978 and May 3, 1987 require Regional Office approval." Therefore, SNL/NM ER personnel consulted directly with EPA Region VI and NMED representatives.

Using the methodology established in the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), the PCB cleanup level for 10^{-4} risk is calculated to be 25 mg/kg. CERCLA also recommends that a more conservative cleanup level of 10 mg/kg be considered for a residential land-use scenario (EPA March 1996). In consultation with EPA and NMED DOE Oversight Bureau (DOE-OB) personnel, a level of 10 mg/kg was chosen as an appropriate, conservative standard for removal of PCBs at Site 18.

2.2 Exceptions to the VCM Plan

Only minor exceptions to the original Site 18 VCM plan were necessary during the actual removal activity. The original area to be remediated was estimated at 15 ft by 50 ft. The actual area remediated was approximately 20 ft by 40 ft (Figure 2-1). This was a result of more accurate delineation of the contaminated area through the use of field screening for PCBs. Total depth of the excavation remained at the estimated

6 inches, with minor additional digging in a few areas (Figure 2-2). Additional soil was removed to ensure a "clean" depth, as indicated by field screening (i.e., concentrations below 1 mg/kg). As anticipated, none of the excavated areas exceeded a depth of 4 feet, so no slope stabilization or shoring was necessary.

2.3 VCM and Verification Sampling Results

Immunoassay field screening was used to identify the area of PCB-impacted soil (Figure 2-1) and to verify that contaminated soil had been removed. Subsequent to completion of the soil removal, confirmation soil samples were collected from the sides and bottom of the excavation, in consultation with on-site NMED/DOE-OB personnel. Eight soil samples (Figure 2-2) were submitted for off-site laboratory analysis of PCBs in accordance with EPA Method 8080. A summary of analytical results for the confirmation soil samples is provided in Table 2-1. As was the case during the RFI sampling, the only detected PCB was Aroclor-1254, ranging from 0.041 to 2.1 mg/kg. None of the confirmation soil samples exceeded the cleanup level of 10 mg/kg PCBs.

2.4 Conclusions

Based on the results of the confirmatory sampling conducted subsequent to the removal of PCB-impacted soil at ER Site 18, the VCM is considered complete. None of the confirmatory samples exceeded the cleanup criterion of 10 mg/kg. Therefore, the VCM accomplished the stated goal of removing all soil that exceeded this limit.

Table 2-1: Summary of Site 18 RFI Post-VCM Confirmatory Soil Sample Analytical Results, August 1996.

Sample Number	ER Sample ID	Sample Depth (ft)	Aroclor-1254 (mg/kg)	Aroclor-1254 Detection Limit (mg/kg)
031021	TA3/5-18-D1-001	0 - 0.5	0.950	0.350
031022	TA3/5-18-D1-002	0 - 0.5	2.1	0.340
031023	TA3/5-18-D1-003	0 - 0.5	1.0	0.340
031024	TA3/5-18-D1-004	0 - 0.5	0.094	0.034
031025	TA3/5-18-D1-005	0 - 0.5	0.300	0.033
031026	TA3/5-18-D1-006	0 - 0.5	0.120	0.033
031027	TA3/5-18-D1-007	0 - 0.5	0.041	0.033
031028	TA3/5-18-D1-008	0 - 0.5	0.110	0.034
Risk-Based Action Level or Cleanup Level			10	NA

Notes: NA - Not analyzed; not applicable. ND - Not detected at the MDL.

3.0 REFERENCES

EPA, March 1996. Memorandum from Nancy Morlock (EPA Region VI) to Elmer Klavetter (SNL/NM ER Project), transmitting information on PCB regulatory policies and cleanup levels.

SNL/NM, June 1996. Results of the Technical Areas III and V RCRA Facility Investigation.

SNL/NM, May 1996. Sandia National Laboratories, New Mexico, Voluntary Corrective Measure Plan, Environmental Restoration Site Number 18, Concrete Pad, Technical Area III.

Section 6.2
Site 18 Risk Assessment Analyses

ER SITE 18: RISK ASSESSMENT ANALYSIS

I. Site Description and History

The Concrete Pad is a 400-ft by 125-ft concrete surface located in central TA-III at the southern end of the Short Sled Track (ER Site 240). Constructed in 1979, the pad has been used to store transformers, capacitors, rocket motors, generators, and rocket fuel inhibitors from TA-III activities, primarily sled track experiments. Because of the nature of some sled track activities, equipment might have been contaminated with HE residue, cadmium, chromium, zinc and other metals, and DU; transformers might have leaked oil or PCBs.

II. Risk Assessment Analysis

Risk assessment of this site includes a number of steps which culminate in a quantitative evaluation of the potential adverse human health effects caused by constituents located at the site. The steps to be discussed include:

Step 1.	Site data are described which provide information on the potential constituents of concern (COC), as well as the relevant physical characteristics and properties of the site.
Step 2.	Potential pathways by which a representative population might be exposed to the COCs are identified.
Step 3.	The potential intake of these COCs by the representative population is calculated using a tiered approach. The tiered approach includes screening steps, followed by potential intake calculations and a discussion or evaluation of the uncertainty in those calculations. Potential intake calculations are also applied to background screening data.
Step 4.	The potential toxicity and cancer effects from exposure to the COCs and associated background constituents and subsequent intake are discussed.
Step 5.	Potential toxicity effects (specified as a Hazard Index) and cancer risks are calculated for nonradiological COCs and background. For radiological COCs, the incremental total effective dose equivalent (TEDE) and incremental estimated cancer risk are calculated by subtracting applicable background concentrations directly from maximum on-site contaminant values. This background subtraction only occurs when a radiological COC occurs as contamination and exists as a natural background radionuclide.
Step 6.	These values are compared with standards established by the United States (U.S.) Environmental Protection Agency (USEPA) and U.S. Department of Energy (USDOE) to determine if further evaluation, and potential site clean-up, is required. Nonradiological COC risk values are also compared to background risk so that an incremental risk may be calculated.
Step 7.	Uncertainties in the previous steps are discussed.

II.1 Step 1. Site Data

Site history and characterization activities are used to identify potential COCs. The identification of COCs and the sampling to determine the concentration levels of those COCs across the site are described in the ER Site 18 No Further Action Proposal. In order to provide conservatism in this risk assessment, the calculation uses only the maximum concentration value of each COC determined for the entire site. Chemicals that are essential nutrients such as iron, magnesium, calcium, potassium, and sodium were not included in this risk assessment (USEPA 1989a). Both radioactive and nonradioactive COCs are evaluated. The nonradioactive COCs evaluated are both metals and organics.

II.2 Step 2. Pathway Identification

The future land-use scenario for ER Site 18 has been identified as industrial (USDOE, 1996)(see Appendix 1 for default exposure pathways and parameters). Because of the location and the characteristics of the potential contaminants, the primary pathway for human exposure is considered to be soil ingestion for chemical COCs and direct gamma exposure for the radiological COCs. The inhalation pathway for both chemicals and radionuclides is included because of the potential to inhale dust and volatiles. No contamination below a depth of 6 ft bgs was detected and therefore no water pathways to the groundwater are considered. Depth to groundwater at Site 18 is approximately 460 feet. Because of the lack of surface water or other significant mechanisms for dermal contact, the dermal exposure pathway is considered to be not significant. No intake routes through plant, meat, or milk ingestion are considered appropriate for the industrial land-use scenario. However, plant uptake is considered for the residential land-use scenario.

PATHWAY IDENTIFICATION

Chemical Constituents	Radionuclide Constituents
Soil Ingestion	Soil Ingestion
Inhalation (Dust and volatiles)	Inhalation (Dust and Volatiles)
Plant uptake (Residential only)	Plant uptake (Residential only)
	Direct Gamma

II.3 Steps 3-5. Calculation of Hazard Indices and Cancer Risks

Steps 3 through 5 are discussed in this section. These steps include the discussion of the tiered approach in eliminating potential COCs from further consideration in the risk assessment process and the calculation of intakes from all identified exposure pathways, the discussion of the toxicity information, and the calculation of the hazard indices and cancer risks. The tiered approach for the risks from Site 18 COCs are discussed first.

First, the maximum concentrations of COCs were compared to TA-III/V specific background screening levels using 95th upper tolerance limits (UTLs) or percentile values (SNL/NM, 1996). If a maximum concentration of a particular COC exceeded the TA-III/V specific background screening level, then the COC was compared to the SNL/NM site-wide background screening level for this area (IT, 1996). If a SNL/NM-specific screening level was not available for a constituent, then a background value was obtained, when possible, from the U.S. Geological Survey (USGS) National Uranium Resource Evaluation (NURE) program (USGS, 1994). It should be noted that, due to the relatively short half-live of Co-60, this radiological COC was corrected for decay that has occurred since the samples were taken in 1994.

The maximum concentration of each COC was used in order to provide a conservative estimate of the associated risk. If any single nonradiological COC was above both the TA-III/V and SNL/NM site-wide background screening levels or the USGS background value, all nonradiological COCs were considered in further risk assessment analyses.

For radiological COCs that exceeded both the TA-III/V specific and the SNL/NM site-wide background screening levels, background values were subtracted from the individual maximum radionuclide concentrations. Those that did not exceed these background levels were not carried any further in the risk assessment. This approach is consistent with USDOE orders. Radioactive COCs that did not have a background value and were detected above the analytical minimum detectable activity (MDA) were carried through the risk assessment at their maximum levels. This step is performed (rather than carry the below-background radioactive COCs through the risk assessment and then perform a background risk assessment to determine incremental TEDE and estimated cancer risk) to prevent the "masking" of radiological contamination that may occur if on-site background radiological COCs exist in concentrations far enough below the assigned background level. When this "masking" occurs the final incremental TEDE and estimated cancer risk are reduced and, therefore, provide a non-conservative estimate of the potential impact on an on-site receptor. This approach is also consistent with the regulatory approach (40 CFR Part 196, 1994) which sets a TEDE limit to the on-site receptor in excess of background. The resultant radioactive COCs remaining after this step are referred to as background-adjusted radioactive COCs.

Second, if any nonradiological COC failed the initial screening step, the maximum concentration for each nonradiological COC was compared with action levels calculated using methods and equations promulgated in the proposed Resource Conservation and Recovery Act (RCRA) Subpart S (40 CFR Part 264, 1990) and Risk Assessment Guidance for Superfund (RAGS) (USEPA, 1989a) documentation. If there were 10 or fewer COCs and each had a maximum concentration less than one-tenth of the action level, then the site was judged to pose no significant health hazard to humans. If there were more than 10 COCs, the Subpart S screening procedure was skipped.

Third, hazard indices and risk due to carcinogenic effects were calculated using Reasonable Maximum Exposure (RME) methods and equations promulgated in RAGS (USEPA, 1989a). The combined effects of all nonradiological COCs in the soils were calculated. The combined effects of the nonradiological COCs at their respective background concentrations in the soils were also calculated. The most conservative background concentration between the TA-III/V specific and SNL/NM concentration (minimum value of the 95th UTL or percentile concentration value, as applicable) was used in the risk calculation. For toxic compounds, the combined effects were calculated by summing the individual hazard quotients for each compound into a total Hazard Index which was then compared to the recommended standard of 1. For potentially carcinogenic compounds, the individual risks were summed. The total risk was compared to the recommended acceptable risk range of 10^{-4} to 10^{-6}. For the radioactive COCs, the incremental TEDE was calculated and the corresponding incremental cancer risk estimated using USDOE's RESRAD computer code.

II.3.1 Comparison to Background and Action Levels

Nonradioactive ER Site 18 COCs (nonorganic) are listed in Table 1, and radioactive COCs are listed in Table 2. Both tables show the associated 95th percentile or UTL background levels (SNL/NM, 1996; IT, 1996). Because organic compounds do not have calculated background values, they are not included in Table 1.

The TA-III/V background levels were submitted for regulatory approval in June 1996, and have not yet been approved by the USEPA or the NMED, but are the result of statistical analyses of samples collected from background areas within TA-III/V. USEPA guidance documents (USEPA, 1989b; 1992a; and 1992b) were followed to arrive at the background levels. The SNL/NM site-wide background levels have not yet been approved by the USEPA or the NMED but are the result of a comprehensive study of joint SNL/NM and U.S. Air Force data from the Kirtland Air Force Base (KAFB). The report was submitted for regulatory review in early 1996. The values shown in Table 1 supersede the background values described in an interim background study report (IT, 1994).

Several compounds have maximum measured values greater than background screening levels. Therefore all nonradiological COCs were retained for further analysis, with the exception of lead. The maximum concentration value for lead is 60.4 mg/kg. The USEPA intentionally does not provide any toxicological data on lead and therefore no risk parameter values can be calculated. However, USEPA guidance for the screening value for lead for an industrial land-use scenario is 2000 mg/kg (USEPA, 1996a); for a residential land-use scenario, the

Table 1. Nonradioactive COCs at ER Site 18 and Comparison to the Background Screening Values.

COC name	Maximum concentration (mg/kg)	TA-III/V 95th % or UTL Level (mg/kg)	Is maximum COC concentration less than or equal to the applicable TA-III/V background screening value?	SNL/NM 95th % or UTL Level (mg/kg)	Is maximum COC concentration less than or equal to the applicable SNL/NM background screening value?
Arsenic	3.2	NC	NA	5.6	Yes
Barium	123	341	Yes		
Beryllium	0.74	0.7	No	0.65	No
Cadmium	18.9	2.6	No	<1	No
Chromium, total*	66.5	NC	NA	1	No
Copper	95.7	14.5	No	15.4	No
Lead	60.4	24.8	No	21.4	No
Mercury	0.11	NC	NA	<0.25^	No
Nickel	35.7	12.9	No	11.5	No
Uranium, total	0.9	4.0	Yes		
Zinc	70	41.8	No	62	No

NC - not calculated
*total chromium assumed to be chromium VI (most conservative), site specific UTL not calculated
NA - not applicable
^ uncertainty due to detection limits

Table 2. Radioactive COCs at ER Site 18 and Comparison to the Background Screening Values.

COC name	Maximum concentration (pCi/g)	SNL/NM 95th % or UTL Level (pCi/g)	Is maximum COC concentration less than or equal to the applicable SNL/NM background screening value?
Co-60	3.53*	NC	No
Ra-226	0.46	2.30	Yes
Ra-228	0.632	1.01	Yes
Th-232	0.632	1.01	Yes
U-238	0.96	1.4	Yes
U-235	0.03	0.16	Yes
U233/234	0.64	1.6	Yes

NC - not calculated
* Decay-corrected
values and therefore lead is eliminated from further consideration in this risk assessment.

USEPA screening guidance value is 400 mg/kg (USEPA, 1994a). The maximum concentration value for lead at this site is less than both of those screening

Because organic compounds do not have calculated background values, this screening step was skipped, and all organics were carried into the risk assessment analyses.

Because several nonradiological COCs had concentrations greater than their respective TA-III/V specific or SNL/NM site-wide background 95th percentile or UTL, the site failed the background screening criteria, and all nonradiological COCs were carried to the proposed Subpart S action level screening procedure. Because the ER Site 18 sample set had more than 10 COCs that continued past the first screening level, the proposed Subpart S screening process was skipped. All remaining nonradiological COCs must have a Hazard Index value and an excess cancer risk value calculated. Radioactive contamination does not have pre-determined action levels analogous to proposed Subpart S and therefore this step in the screening process was not performed for radionuclides.

II.3.2 Identification of Toxicological Parameters

Tables 3 and 4 show the COCs that have been retained in the risk assessment and the values for the toxicological information available for those COCs. Dose conversion factors (DCFs) used in determining the incremental TEDE values for the individual pathways were the default values provided in the RESRAD computer code as developed in the following:

- For ingestion and inhalation, DCFs are taken from Federal Guidance Report No. 11, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion* (USEPA, 1988a).

- The DCFs for surface contamination (contamination on the surface of the site) were taken from USDOE/EH-0070, *External Dose-Rate Conversion Factors for Calculation of Dose to the Public* (USDOE, 1988).

- The DCFs for volume contamination (exposure to contamination deeper than the immediate surface of the site) were calculated using the methods discussed in, *Dose-Rate Conversion Factors for External Exposure to Photon Emitters in Soil* (Kocher, D.C., 1983), and ANL/EAIS-8, *Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil* (Yu, C., et al., 1993a).

Table 3. Nonradioactive Toxicological Parameter Values for ER Site 18 COCs

COC name	RfD_o (mg/kg/d)	RfD_{inh} (mg/kg/d)	Confidence	SF_o (kg-d/mg)	Sf_{inh} (kg-d/mg)	Cancer Class ^
Arsenic	0.0003	--	M	1.5	15.1	A
Barium	0.07	0.000143	M	--	--	D
Beryllium	0.005	--	L	4.3	8.4	B2
Cadmium	0.0005	0.0000571	H	--	6.3	B1
Chromium, total*	0.005	--	L	--	42	A
Copper	0.04	--	Est.	--	--	D
Mercury	0.0003	0.0000857	--	--	--	D
Nickel	0.02	--	--	--	--	D
Uranium, total	0.003	--	--	--	--	D
Zinc	0.3	--	M	--	--	D
TPH	--	--	--	--	--	--
PCBs (Aroclor - 1254)	--	--	--	7.7	--	B2

* total chromium assumed to be chromium VI (most conservative)
RfD_o - oral chronic reference dose in mg/kg-day
RfD_{inh} - inhalation chronic reference dose in mg/kg-day
Confidence - L = low, M = medium, H = high, Est. = estimated
SF_o - oral slope factor in $(mg/kg\text{-}day)^{-1}$
SF_{inh} - inhalation slope factor in $(mg/kg\text{-}day)^{-1}$
^ USEPA weight-of-evidence classification system for carcinogenicity:

- A - human carcinogen
- B1 - probable human carcinogen. Limited human data are available
- B2 - probable human carcinogen. Indicates sufficient evidence in animals and inadequate or no evidence in humans.
- C - possible human carcinogen
- D - not classifiable as to human carcinogenicity
- E - evidence of noncarcinogenicity for humans

-- information not available

Table 4. Radiological Toxicological Parameter Values for ER Site 18 COCs

COC name	SF_{ev} (g/pCi-yr)	SF_o (1/pCi)	Sf_{inh} (1/pCi)	Cancer Class^
Co-60	9.8E-06	1.9E-11	6.9E-11	A

Sf_{ev}- external volume exposure slope factor (risk/yr per pCi/g)
SF_o - oral (ingestion) slope factor (risk/pCi)
SF_{inh} - inhalation slope factor (risk/pCi)
^ USEPA weight-of-evidence classification system for carcinogenicity:

A - human carcinogen
B1 - probable human carcinogen. Limited human data are available
B2 - probable human carcinogen. Indicates sufficient evidence in animals and inadequate or no evidence in humans.
C - possible human carcinogen
D - not classifiable as to human carcinogenicity
E - evidence of noncarcinogenicity for humans

II.3.3 Exposure Assessment and Risk Characterization

Section II.3.3.1 describes the exposure assessment for this risk assessment. Section II.3.3.2 provides the risk characterization including the Hazard Index value and the excess cancer risk for both the potential nonradiological COCs and associated background for industrial and residential land-uses. The incremental TEDE and incremental estimated cancer risk are provided for the background-adjusted radiological COCs for industrial and residential land-uses.

II.3.3.1 Exposure Assessment

Appendix 1 shows the equations and parameter values used in the calculation of intake values and the subsequent Hazard Index and excess cancer risk values for the individual exposure pathways. The appendix shows the parameters for both industrial and residential land-use scenarios. The equations are based on RAGS (USEPA, 1989a). The parameters are based on information from RAGS (USEPA, 1989a) as well as other USEPA guidance documents and reflect the RME approach advocated by RAGS (USEPA, 1989a). For radionuclides, the coded equations provided in the RESRAD computer code were used to estimate the excess TEDE and cancer risk for the individual exposure pathways. Further discussion of this process is provided in Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0 (Yu, C., et al., 1993b).

Although the designated land-use scenario is industrial for this site, the risk and TEDE values for a residential land-use scenario are also presented. These residential risk and TEDE values are presented only to provide perspective on the potential for risk to human health under the more restrictive residential land-use scenario.

II.3.3.2 Risk Characterization

Table 5 shows that for the ER Site 18 nonradioactive COCs, the Hazard Index value is 0.06 and the excess cancer risk is 1×10^{-5} for the designated industrial land-use scenario. The numbers presented include exposure from soil ingestion and dust and vapor inhalation for the nonradioactive COCs. Table 6 shows that for the ER Site 18 associated nonradiological background constituents, the Hazard Index is 0.02 and the excess cancer risk is 5×10^{-6} for the designated industrial land-use scenario.

Table 5. Nonradioactive Risk Assessment Values for ER Site 18 COCs

COC Name	Maximum concentration (mg/kg)	Industrial Land-Use Scenario		Residential Land-Use Scenario	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Arsenic	3.2	0.01	2E-6	0.18	4E-5
Barium	123	0.00	--	0.02	--
Beryllium	0.74	0.00	1E-6	0.00	6E-6
Cadmium	18.9	0.04	8E-9	15.45	1E-8
Chromium, total*	66.5	0.01	2E-7	0.05	3E-7
Copper	95.7	0.00	--	0.43	--
Mercury	0.11	0.00	--	0.19	--
Nickel	35.7	0.00	--	0.05	--
Uranium, total	0.9	0.00	--	0.00	--
Zinc	70	0.00	--	0.13	--
TPH	20	--	--	--	--
PCBs (Aroclor-1254)	2.3	0.00	7E-6	0.00	3E-5
TOTAL		**0.06**	**1E-5**	**17**	**8E-5**

* total chromium assumed to be chromium VI (most conservative)
-- information not available

Table 6. Nonradioactive Risk Assessment Values for ER Site 18 Background Constituents.

Constituent Name	Background concentration (mg/kg)	Industrial Land-Use Scenario		Residential Land-Use Scenario	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Arsenic	5.6	0.02	4E-6	0.32	6E-5
Barium	130	0.00	--	0.02	--
Beryllium	0.65	0.00	1E-6	0.00	5E-6
Cadmium	<1	--	--	--	--
Chromium, total*	1	0.00	3E-9	0.00	4E-9
Copper	14.5	0.00	--	0.06	--
Mercury	<0.25	--	--	--	--
Nickel	11.5	0.00	--	0.02	--
Uranium, total	3.42	0.00	--	0.01	--
Zinc	41.8	0.00	--	0.08	--
TOTAL		**0.02**	**5E-6**	**0.5**	**7E-5**

-- information not available
* total chromium assumed to be chromium VI (consistent with Table 5)

For the radioactive COCs, contribution from the direct gamma exposure pathway is included. The TEDE for industrial land-use is 10.1 mrem/yr and the estimated excess cancer risk is 2×10^{-4}.

For the residential land-use scenario, the Hazard Index value increases to 17 and the excess cancer risk is 8×10^{-5}. The numbers presented included exposure from soil ingestion, dust and volatile inhalation, and plant uptake.

Although USEPA (1991) generally recommends that inhalation not be included in a residential land-use scenario, this pathway is included because of the potential for soil in Albuquerque, NM, to be eroded and, subsequently, for dust to be present even in predominantly residential areas. Because of the nature of the local soil, other exposure pathways are not considered (see Appendix 1). Table 6 shows that for the ER Site 18 associated nonradiological background constituents, the Hazard Index is to 0.5 and the excess cancer risk is 7×10^{-5}.

For the radioactive COCs, contribution from the direct gamma exposure pathway is included. The TEDE for residential land-use is 28.6 mrem/yr and the estimated excess cancer risk is 5×10^{-4}.

II.4 Step 6. Comparison of Risk Values to Numerical Standards.

The risk assessment analyses considered the evaluation of the potential for adverse health effects for both an industrial land-use scenario, which is the designated land-use scenario for this site, and for a residential land-use scenario.

For the industrial land-use scenario, the Hazard Index calculated for the maximum values of the nonradioactive COCs is 0.06; this is much less than the numerical standard of 1 suggested in RAGS (USEPA, 1989a). The excess cancer risk is estimated at 1×10^{-5}. In RAGS, the USEPA suggests that a range of values (10^{-6} to 10^{-4}) be used as the numerical standard; the value calculated for this site is in the middle of the suggested acceptable risk range. Therefore, for an industrial land-use scenario, the Hazard Index risk assessment values are significantly less than the established numerical standards and the excess cancer risk is in the middle of the suggested acceptable risk range.

This risk assessment also determined risks considering background concentrations of the potential nonradiological COCs for both the industrial and residential land-use scenarios. For the industrial land-use scenario, the Hazard Index is 0.02. The excess cancer risk is estimated at 5×10^{-6}. Incremental risk is determined by subtracting risk associated with background from potential nonradiological COC risk . These numbers are not rounded before the difference is determined and therefore may appear to be inconsistent with numbers presented in tables and discussed within the text. The incremental Hazard Index is 0.04 and the incremental cancer risk is 5×10^{-6} for the industrial land-use scenario.

For the radioactive components of the industrial land-use scenario, the calculated incremental TEDE is 10.1 mrem/yr. In accordance with proposed USEPA guidance, the standard being utilized is an incremental TEDE of 15 mrem/yr (40 CFR Part 196, 1994) for the probable land-use scenario (industrial in this case); the calculated TEDE for ER Site 18 for an industrial land-use is below this standard. The estimated incremental cancer risk is 2×10^{-4} for the industrial land-use scenario. The estimated incremental cancer risk from the nonradioactive COCs and the radioactive COCs is not additive, as noted in RAGS (USEPA, 1989a).

For the residential land-use scenario, the calculated Hazard Index for the nonradioactive COCs is 17, which is greater than the numerical guidance. The excess cancer risk is estimated at 8 x 10^{-5}; this value is in the upper end of the suggested acceptable risk range. The Hazard Index for associated background for the residential land-use scenario is 0.5. The excess cancer risk is estimated at 7 x 10^{-5}. For the residential land-use scenario, the incremental Hazard Index is 16 and the incremental cancer risk is 1.1 x 10^{-5}.

The incremental TEDE from the radioactive components is 28.6 mrem/yr. In accordance with proposed USEPA guidance, the standard being utilized is an excess TEDE of 75 mrem/yr (40 CFR Part 196, 1994) for a complete loss of institutional controls (residential land-use in this case); the calculated TEDE for ER Site 18 for the residential land-use are well below this standard. The associated incremental cancer risk is 5 x 10^{-4}. The cancer risk from the nonradioactive COCs and the radioactive COCs is not additive, as noted in RAGS (USEPA, 1989a).

II.5 Step 7 Uncertainty Discussion

The data used to characterize ER Site 18, the Concrete Pad, consisted of 12 samples collected from the surface soils adjacent to the pad. The samples were collected in accordance with the approved OU 1306 (TA-III/V) RFI Work Plan from areas determined to be potentially contaminated and from locations selected by a random number generator based on a 5-ft grid pattern around the pad. The COCs for the site were polychlorinated biphenyls (PCBs), total petroleum hydrocarbons (TPH), depleted uranium (DU), high explosives (HEs), and a variety of metals, including cadmium, chromium, copper, lead, and zinc. The soil samples were analyzed at an offsite laboratory for PCBs in accordance with USEPA Method 8080, for TPH per USEPA Method 418.1, for HEs per USEPA Method 8330, for metals by USEPA Methods 6010/7000, and for DU by isotopic uranium and gamma spectroscopy (the latter analysis was conducted by an on-site SNL/NM radiological laboratory). QA/QC samples included a field duplicate (soil), aqueous field and equipment blanks, and a matrix spike/matrix spike duplicate (MS/MSD). The data provided by the off-site laboratory is considered definitive data suitable for use in a risk assessment analysis.

The conclusion from the risk assessment analysis is that the potential effects caused by potential nonradiological COCs on human health are within the acceptable range compared to established numerical standards for the industrial land-use scenario. Calculated incremental risk between potential nonradiological COCs and associated background indicate small contribution of risk from nonradiological COCs when considering the industrial land-use scenario.

The main contributors to the adverse effects on human health are arsenic (3.2 mg/kg), beryllium (0.74 mg/kg), cadmium (18.9 mg/kg), and PCBs

(2.1 mg/kg). The maximum arsenic concentration (3.2 mg/kg) was below its background screening value.

For the radiological COCs the conclusion from the risk assessment is that the potential effects on human health, for the industrial land-use scenario, are well within the proposed standard (40 CFR Part 196, 1994) and are a small fraction of the estimated 290 mrem/yr received due to natural background (NCRP, 1987).

The potential effects on human health, for the nonradiological COCs, are greater when considering the residential land-use scenario. Incremental risk between potential nonradiological COCs and associated background also indicates an increased contribution of risk from the nonradiological COCs. The increased effects on human health are primarily the result of including the plant uptake exposure pathway. Constituents that posed little to no risk considering an industrial land-use scenario (some of which are below background screening levels), contribute a significant portion of the risk associated with the residential land-use scenario. These constituents bioaccumulate in plants. Because TA-III/V is an industrial site and is designated as an industrial land-use area (USDOE, 1996), the likelihood of significant plant uptake in this area is highly unlikely. The uncertainty in this conclusion is considered to be small.

For the radiological COCs the conclusion from the risk assessment is that the potential effects on human health, for the residential land-use scenario, is well within the proposed standard (40 CFR Part 196, 1994) and is a small fraction of the estimated 290 mrem/yr received due to natural background (NCRP, 1987).

Because of the location, history of the site and the future land-use (USDOE, 1996), there is low uncertainty in the land-use scenario and the potentially affected populations that were considered in making the risk assessment analysis. Because the COCs are found in surface and near-surface soils and because of the location and physical characteristics of the site, there is little uncertainty in the exposure pathways relevant to the analysis. The approach taken in determining the potential TEDE to a receptor at Site 18 is also considered to be extremely conservative since residual Co-60 was only found in a small 1 yd^2 area but, in the risk assessment, it was assumed that Co-60 was uniformly distributed over the entire site at a depth of 6 in. As the predominant pathway for Co-60 is direct gamma exposure this large land area assumption provided for very conservative TEDE estimation.

An RME approach was used to calculate the risk assessment values, which means that the parameter values used in the calculations were conservative and that the calculated intakes are likely overestimates. Maximum measured values of the concentrations of the COCs and minimum value of the 95th UTL or percentile background concentration value, as applicable, of background concentrations associated with the COCs were used to provide conservative results.

Table 3 shows the uncertainties (confidence) in the nonradiological toxicological parameter values. There is a mixture of estimated values and values from the Health Effects Assessment Summary Tables (HEAST) (USEPA, 1996b) and Integrated Risk Information System (IRIS) (USEPA, 1988b, 1994b) data bases. Where values are not provided, information is not available from HEAST, IRIS, or USEPA regions. The constituents without any toxicological parameters are judged to be insignificant contributors to the overall risk. Because of the conservative nature of the RME approach, the uncertainties in the toxicological values are not expected to be of high enough concern to change the conclusion from the risk assessment analysis.

The nonradiological risk assessment values are within the acceptable range for the industrial land-use scenario compared to the established numerical standards. Although the residential land-use Hazard Index is above the numerical standard, it has been determined that future land-use at this locality will not be residential (USDOE, 1996). The radiological incremental TEDE is a very small fraction of estimated background TEDE for both the industrial and residential land-use scenarios and both are well within proposed standards (40 CFR Part 196, 1994). The overall uncertainty in all of the steps in the risk assessment process is considered insignificant with respect to the conclusion reached.

II.6 Summary

The TA-III/V Concrete Pad, ER Site 18, had relatively minor contamination consisting of some inorganic and organic nonradioactive and radioactive compounds. Because of the location of the site on KAFB, the designated industrial land-use scenario (USDOE, 1996), and the nature of the contamination, the potential exposure pathways identified for this site included soil ingestion and dust/volatile inhalation for chemical constituents and soil ingestion, dust/volatile inhalation, and direct gamma exposure, for radionuclides. Plant uptake was included as an exposure pathway for the residential land-use scenario. This site is designated for industrial land-use (USDOE, 1996); the residential land-use scenario is provided for perspective only.

The main contributors to the industrial land-use scenario risk assessment values are arsenic, beryllium, cadmium, and PCBs. The maximum arsenic concentration was below its background screening value. PCBs are known to have been used at TA-III/V.

Using conservative assumptions and employing a RME approach to the risk assessment, the calculations for the nonradiological COCs show that for the industrial land-use scenario the Hazard Index (0.06) is significantly less than the accepted numerical guidance from the USEPA. The estimated cancer risk (1×10^{-5}) is in the middle of the suggested acceptable risk range. The incremental Hazard Index is 0.04 and the incremental cancer risk is 5×10^{-6} for the industrial land-use scenario. Incremental risk calculations indicate insignificant risk to human health from the nonradiological COCs considering an industrial land-use scenario.

The incremental TEDE and corresponding estimated cancer risk from the radioactive components are less than USEPA guidance values; the estimated incremental TEDE is 10.1 mrem/yr for the industrial land-use scenario. This value is less than the numerical guidance of 15 mrem/yr in draft USEPA guidance. The corresponding incremental estimated cancer risk value is 2×10^{-4} for the industrial land-use scenario.

The calculations for the nonradiological COCs show that for the residential land-use scenario the Hazard Index (17) is greater than the accepted numerical guidance from the USEPA. The estimated cancer risk (8×10^{-5}) is at the upper end of the suggested acceptable risk range. The increased effects on human health are primarily the result of the inclusion of the plant uptake exposure pathway. Nonradiological constituents that posed little to no risk considering an industrial land-use scenario (some of which are below background screening levels), contribute a significant portion of the risk associated with the residential land-use scenario. These constituents bioaccumulate in plants. Because TA-III/V is an industrial site (USDOE, 1996), the likelihood of significant plant uptake in this area is highly unlikely. For the residential land-use scenario, the incremental Hazard Index is 16 and the incremental cancer risk is 1.1×10^{-5}. Increased risk from the nonradiological COCs was evident considering residential land-use, due to plant uptake, but future utilization will be restricted to industrial land-use.

The incremental TEDE and corresponding estimated cancer risk from the radioactive components are much less than USEPA guidance values; the estimated incremental TEDE is 28.6 mrem/yr for the residential land-use scenario. This value is much less than the numerical guidance of 75 mrem/yr in draft USEPA guidance. The corresponding incremental estimated cancer risk value is 5×10^{-4} for the residential land-use scenario.

The uncertainties associated with the calculations are considered small relative to the conservativeness of the risk assessment analysis. It is therefore concluded that this site does not have significant potential to affect human health under an industrial land-use scenario.

III. Ecological Risk Assessment

III.1 Introduction

This section addresses the ecological risks associated with exposure to constituents of potential ecological concern (COPECs) in soils from SNL/NM

ER Site 18. The ecological risk assessment process performed for this site is a screening level assessment which follows the methodology presented in IT (1997) and SNL/NM (1996b). The methodology was based on screening level guidance presented by USEPA (USEPA, 1992c; 1996c; 1996d) and by Wentsel, et al. (1996) and is consistent with a phased approach. This assessment utilizes conservatism in the estimation of ecological risks, however, ecological relevance and professional judgment are also incorporated as recommended by USEPA (1996c) and Wentsel et al., (1996) to insure that the predicted exposures of selected ecological receptors reasonably reflect those expected to occur at the site.

III.2 Ecological Pathways

The area of Site 18 consists of a disturbed soil surface surrounded by desert grassland vegetation. The topography is flat and there are no major drainages or surface water features in the area. Complete ecological pathways may exist at this site through the exposure of plants and wildlife to COPECs in surface and subsurface soil. No threatened, endangered, or other special status species are known to occur at the site. Site 18 was included within the boundaries of a previous sensitive species survey conducted in the spring and summer of 1992 and 1993 (Sullivan and Knight, 1994). This survey classified the undisturbed habitat in this part of TA-III as Sensitivity Zone 4 indicating that the habitat is unlikely to contain grama grass cactus (Pediocactus papyracanthus), a species that was previously listed as endangered in New Mexico, but has been delisted.

III.3 Constituents of Potential Ecological Concern

The potential COCs at this site include target analyte list metals and total uranium. Following the screening process used for the selection of potential COCs for the human health risk assessment, the inorganic COCs were screened against background upper tolerance limits (UTLs). Nine inorganic analytes, beryllium, cadmium, chromium (total), copper, lead, mercury, nickel, uranium, and zinc were identified as COPECs at Site 18. Chemicals that are essential nutrients such as iron, magnesium, calcium, potassium, and sodium were not included in this risk assessment per USEPA 1989a. The only radionuclide that was detected in soil at above background concentrations was Co-60. The maximum concentration of this radionuclide was 3.53 pCi/g.

III.4 Receptors and Exposure Modeling

A non-specific perennial plant was used as the receptor to represent plant species at the site. Two wildlife receptors (deer mouse and burrowing owl) were used to represent wildlife use of the site. Exposure modeling for the wildlife receptors was limited to the food ingestion pathway. Inhalation and dermal contact were considered insignificant pathways with respect to ingestion.

Drinking water was also considered an insignificant pathway because of the lack of surface water at this site. The deer mouse was modeled as an omnivore (50 percent of the diet as plants and 50 percent as soil invertebrates) and the burrowing owl as a strict predator on small mammals (100 percent of the diet as deer mice). Both were modeled with soil ingestion comprising 2 percent of the total dietary intake. Table 7 presents the species-specific factors used in modeling exposures in the wildlife receptors. Although home range is also included in this table, exposures for this screening-level assessment were modeled using an area use factor of 1, implying that all food items and soil ingested are from the site being investigated.

The maximum measured COPEC concentrations from both surface and subsurface soil samples were used to conservatively estimate potential exposures and risks to plants and wildlife at this site.

Table 8 presents the transfer factors used in modeling the concentrations of COPECs through the food chain. Table 9 presents the maximum concentrations of COPECs in soil, the derived concentrations in the various food-chain elements, and the modeled dietary exposures for each of wildlife receptor species.

With respect to exposure of the receptors to Co-60, external dose to the deer mouse and burrowing owl were estimated using a dose model developed by Pacific Northwest Laboratories (USDOE, 1995). Default values used in the model were a value of 1.5 g/cm^3 for the density of soil and a value of 1.25 MeV as the average gamma energy per disintegration for Co-60. A detailed description of the method to estimate radiation dose to these receptors is presented in DOE, 1995 and IT, 1997. Because Co-60 is a gamma emitter, internal dose was assumed to be insignificant compared to external dose (USDOE, 1995) and was therefore not quantitatively evaluated.

III.5 Toxicity Benchmarks

Benchmark toxicity values for the plant and wildlife receptors are presented in Table 10. For plants, the benchmark soil concentrations are based on the Lowest-Observed-Adverse-Effect-Level (LOAEL) with the adverse effect being a 20 percent reduction of growth. For wildlife, the toxicity benchmarks are based on the No-Observed-Adverse-Effect-Level (NOAEL) for chronic oral exposure in a taxonomically similar test species. Total chromium was assumed to be primarily composed of Cr+3 and mercury in these soils was assumed to be inorganic in form. Toxicity information was insufficient to estimate the NOAEL for beryllium in birds.

Table 7. Exposure Factors for Ecological Receptors at Environmental Restoration Site 18, Sandia National Laboratories, New Mexico

Receptor species	Class/Order	Trophic level	Body weight (kg)[a]	Food intake rate (kg/d)[b]	Dietary Composition[c]	Home range (acres)
Deer Mouse (*Peromyscus maniculatus*)	Mammalia/ Rodentia	Omnivore	0.0239[d]	0.00372	Plants: 50% Invertebrates: 50% (+ Soil at 2% of intake)	0. 27[e]
Burrowing owl (*Speotyto cunicularia*)	Aves/ Strigiformes	Carnivore	0.155[f]	0.0173	Rodents: 100% (+ Soil at 2% of intake)	34.6[g]

[a]Body weights are in kilograms wet weight.
[b]Food intake rates are estimated from the allometric equations presented in Nagy (1987). Units are kilograms dry weight per day.
[c]Dietary compositions are generalized for modeling purposes. Default soil intake value of 2% of food intake.
[d]From Silva and Downing (1995).
[e]From USEPA (1993), based on the average home range measured in semi-arid shrubland in Idaho.
[f]From Dunning (1993).
[g]From Haug et al. (1993)

Table 8. Transfer Factors Used in Exposure Models for Constituents of Potential Ecological Concern at Environmental Restoration Site 18, Sandia National Laboratories, New Mexico

Constituent of Potential Ecological Concern	Soil-to-Plant Transfer Factor	Soil-to-Invertebrate Transfer Factor	Food-to-Muscle Transfer Factor
Beryllium	1.00×10^{-2} [a]	1.00×10^{0} [b]	1.00×10^{-3} [a]
Cadmium	5.50×10^{-1} [a]	6.00×10^{-1} [c]	5.50×10^{-4} [a]
Chromium (total)	4.00×10^{-2} [d]	1.30×10^{-1} [e]	3.00×10^{-2} [d]
Copper	8.00×10^{-1} [f]	2.50×10^{-1} [c]	1.00×10^{-2} [a]
Lead	9.00×10^{-2} [d]	4.00×10^{-2} [c]	8.00×10^{-4} [d]
Mercury	1.00×10^{0} [d]	1.00×10^{0} [b]	2.50×10^{-1} [a]
Nickel	2.00×10^{-1} [c]	3.80×10^{-1} [e]	6.00×10^{-3} [a]
Uranium	1.00×10^{-2} [d]	1.00×10^{0} [b]	1.00×10^{-2} [d]
Zinc	1.50×10^{0} [a]	3.00×10^{-1} [c]	1.00×10^{-1} [a]
PCBs (Aroclor-1254)	1.25×10^{-1} [g]	2.64×10^{1} [h]	3.19×10^{-2} [g]

[a]From Baes et al. (1984).
[b]Default value.
[c]From Stafford et al. (1991).
[d]From NCRP (1989).
[e]From Ma (1982).
[f]From IAEA (1994).
[g]From equations developed in Travis and Arms (1988).
[h]From equations developed in Connell and Markwell (1990).

Table 9. Media Concentrations for Constituents of Potential Ecological Concern at Environmental Restoration Site 18, Sandia National Laboratories, New Mexico

Constituent of Potential Ecological Concern	Soil [a] (maximum)	Plant Foliage[a,b]	Soil Invertebrate[a,b]	Deer Mouse Tissues[a,c]
Beryllium	7.40×10^{-1}	7.40×10^{-3}	7.40×10^{-1}	1.21×10^{-3}
Cadmium	1.89×10^{1}	1.04×10^{1}	1.13×10^{1}	1.93×10^{-2}
Chromium (total)	6.65×10^{1}	2.66×10^{0}	8.65×10^{0}	6.55×10^{-1}
Copper	9.57×10^{1}	7.66×10^{1}	2.39×10^{1}	1.63×10^{0}
Lead	6.04×10^{1}	5.44×10^{0}	2.42×10^{0}	1.28×10^{-2}
Mercury	1.10×10^{-1}	1.10×10^{-1}	1.10×10^{-1}	8.77×10^{-2}
Nickel	3.57×10^{1}	7.14×10^{0}	1.36×10^{1}	2.08×10^{-1}
Uranium	9.00×10^{-1}	9.00×10^{-3}	9.00×10^{-1}	1.48×10^{-2}
Zinc	7.00×10^{1}	1.05×10^{2}	2.10×10^{1}	2.01×10^{1}
PCBs (Aroclor-1254)	2.10×10^{0}	2.62×10^{-2}	5.54×10^{1}	2.77×10^{0}

[a]Milligrams per kilogram. All are based on dry weight of the media.
[b]Product of the soil concentration and the corresponding transfer factor.
[c]Product of the average concentration in food times the food-to-muscle transfer factor times the wet weight-dry weight conversion factor of 3.125 (from USEPA, 1993).

Table 10. Toxicity Benchmarks for Ecological Receptors at Environmental Restoration Site 18, Sandia National Laboratories, New Mexico

		Mammalian NOAELs			Avian NOAELs		
Constituent of Potential Ecological Concern	Plant Benchmark[a]	Mammalian Test Species[b]	Test Species NOAEL[c]	Deer Mouse NOAEL[d]	Avian Test Species[e]	Test Species NOAEL[e]	Burrowing Owl NOAEL[f]
Beryllium	10	Lab rat	0.66	1.29	---[g]	---	---
Cadmium	3	Lab rat	1.0	1.89	Mallard	1.45	1.45
Chromium (total)	1	Lab rat	2737	5350	Black duck	1	1
Copper	100	Mink	11.7	29.8	Chicks	47	47
Lead	50	Lab rat	8	15.7	American kestrel	3.85	3.85
Mercury	0.3	Lab rat	0.032	0.0626	Mallard	0.0064	0.0064
Nickel	30	Lab rat	40	78.2	Mallard	77.4	77.4
Uranium	5	Lab mouse	3.07	3.19	Black duck	16	16
Zinc	50	Lab rat	160	313	Chicken	14.5	14.5
PCBs (Aroclor-1254)	40	Oldfield mouse	0.068	0.059	Ring-necked pheasant	0.18	0.18

[a]From Will and Suter (1995).
[b]From Sample et al. (1996), except where noted. Body weights (in kilograms) for NOAEL conversion are: lab mouse, 0.030; lab rat, 0.350 (except where noted); and mink, 1.0.
[c]From Sample et al. (1996), except where noted.
[d]Based on NOAEL conversion methodology presented in Sample et al. (1996), using a deer mouse body weight of 0.239 kilograms and a mammalian scaling factor of 0.25.
[e]From Sample et al. (1996).
[f]Based on NOAEL conversion methodology presented in Sample et al. (1996). The avian scaling factor of 0.0 was used, making the NOAEL independent of body weight.
[g]--- designates insufficient toxicity data.
[h]No explanation

The benchmark used for exposure of terrestrial receptors to radiation was 0.1 rad/day. This value has been recommended by IAEA (1992) for the protection of terrestrial populations. Because plants and insects are less sensitive to radiation than vertebrates (Whicker and Schultz, 1982), the dose of 0.1 rad per day should also offer sufficient protection to other components within the terrestrial habitat of Site 18.

III.6 Risk Characterization

The maximum soil concentrations and estimated dietary exposures were compared to plant and wildlife benchmark values, respectively. The results of these comparisons are presented in Table 11. Hazard quotients (HQs) are used to quantify the comparison with the benchmarks for wildlife exposure. Maximum measured soil concentrations for cadmium, chromium (total), lead, nickel, and zinc exceeded their respective plant benchmark concentrations. Only the HQ for PCBs (HQ = 72.6) exceeded unity in the deer mouse. In the burrowing owl, the HQs for mercury (HQ = 1.57) and PCBs (HQ=1.74) exceeded unity. The radiation dose to the mouse and owl was predicted to be 6.75×10^{-4} rad/day. This is considerably less than the benchmark of 0.1 rad/day.

III.7 Uncertainties

Many uncertainties are associated with the characterization of ecological risks at ER Site 18. These uncertainties result in the use of assumptions in estimating risk which may lead to an overestimation or underestimation of the true risk presented at a site. For this screening level risk assessment, assumptions are made that are more likely to overestimate risk rather than to underestimate it. These conservative assumptions are used to be more protective of the ecological resources potentially affected by the site. Conservatisms incorporated into this risk assessment include: the use of the maximum soil concentration or maximum detection limit to evaluate risk; the use of wildlife toxicity benchmarks based on NOAEL values; the use of maximum transfer factors found in the literature for modeling plant and mouse tissue concentrations; the use of earthworm-based transfer factors or a default factor of 1.0 for modeling COPECs into soil invertebrates; and, the use of 1.0 as the use factor for wildlife receptors regardless of seasonal use or home range size. Uncertainties associated with the estimation of risk to ecological receptors following exposure to Co-60 are primarily related to those inherent in the dose models and related exposure parameters. The model is based on the assumption that the receptor is underground in soil uniformly contaminated with the maximum detected concentration of Co-60 measured at the site.

Table 11. Comparisons to Toxicity Benchmarks for Ecological Receptors at Environmental Restoration Site 18, Sandia National Laboratories, New Mexico

Constituent of Potential Ecological Concern	Exceeds Plant Hazard Quotient[a]	Deer Mouse Hazard Quotient	Burrowing Owl Hazard Quotient
Beryllium	7.40×10^{-2}	4.68×10^{-1}	---
Cadmium	**6.30×10^{0}**	9.28×10^{-1}	3.05×10^{-2}
Chromium	**6.65×10^{1}**	2.03×10^{-4}	2.21×10^{-1}
Copper	9.57×10^{-1}	2.73×10^{-1}	8.40×10^{-3}
Lead	**1.21×10^{0}**	5.11×10^{-2}	3.53×10^{-2}
Mercury	3.67×10^{-1}	2.79×10^{-1}	**1.57×10^{0}**
Nickel	**1.19×10^{0}**	2.20×10^{-2}	1.33×10^{-3}
Uranium	1.80×10^{-1}	2.30×10^{-2}	2.28×10^{-4}
Zinc	**1.40×10^{0}**	3.20×10^{-2}	1.65×10^{-1}
PCBs (Aroclor-1254)	5.25×10^{-2}	**7.26×10^{1}**	**1.74×10^{0}**

Bold text indicates hazard quotient greater than one.
--- designates insufficient toxicity data available for risk estimation purposes.

III.8 Summary

Potential risks were indicated for all three ecological receptors at ER Site 18, however, the use of the maximum measured soil concentration to evaluate risk provided the "worst case" scenario for the risk assessment and may not reflect actual conditions. As an example, the only area along the Site 18 concrete pad where concentrations of PCBs were detected was within a 700 ft^2 area. This area covers approximately 1/20th of the perimeter around the pad. Based on the limited extent of contamination and the fact that the concrete pad itself does not contain significant ecological habitat, risk to wildlife receptors from PCB exposure at this site is expected to be minimal despite the fact that HQs greater than unity were predicted in the screening assessment. In a similar light, risk was also predicted for vegetation exposed to maximum concentrations of cadmium, chromium, lead, nickel, and zinc in soils from the site. Because the entire buffer zone around the concrete pad is less than half an acre and no sensitive plant species are expected to occur in the area, risk to plant populations and communities within the area is not expected to be significant. Mercury in soil (0.11 mg/Kg) produced a HQ of 1.57 for the owl. This mercury concentration is within the range of background soil concentration. No other chemicals were predicted to be of potential ecological risk at Site 18. The same was found true for cobalt-60 (1.50×10^{-4} rad/day, much less than 0.1 rad/day). Thus, ER Site 18 is not an ecological concern.

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APPENDIX 1.

Sandia National Laboratories Environmental Restoration Program

EXPOSURE PATHWAY DISCUSSION FOR CHEMICAL AND RADIONUCLIDE CONTAMINATION

BACKGROUND

Sandia National Laboratories (SNL) proposes that a default set of exposure routes and associated default parameter values be developed for each future land-use designation being considered for SNL/NM Environmental Restoration (ER) project sites. This default set of exposure scenarios and parameter values would be invoked for risk assessments unless site-specific information suggested other parameter values. Because many SNL/NM ER sites have similar types of contamination and physical settings, SNL believes that the risk assessment analyses at these sites can be similar. A default set of exposure scenarios and parameter values will facilitate the risk assessments and subsequent review.

The default exposure routes and parameter values suggested are those that SNL views as resulting in a Reasonable Maximum Exposure (RME) value. Subject to comments and recommendations by the USEPA Region VI and NMED, SNL proposes that these default exposure routes and parameter values be used in future risk assessments.

At SNL/NM, all Environmental Restoration sites exist within the boundaries of the Kirtland AFB. Approximately 157 potential waste and release sites have been identified where hazardous, radiological, or mixed materials may have been released to the environment. Evaluation and characterization activities have occurred at all of these sites to varying degrees. Among other documents, the SNL/ER draft Environmental Assessment (DOE, 1996) presents a summary of the hydrogeology of the sites, the biological resources present and proposed land use scenarios for the SNL/NM ER sites. At this time, all SNL/NM ER sites have been tentatively designated for either industrial or recreational future land use. The NMED has also requested that risk calculations be performed based on a residential land use scenario. All three land use scenarios will be addressed in this document.

The SNL/NM ER project has screened the potential exposure routes and identified default parameter values to be used for calculating potential intake and subsequent hazard index, risk and dose values. EPA (EPA, 1989a) provides a summary of exposure routes that could potentially be of significance at a specific waste site. These potential exposure routes consist of:

- Ingestion of contaminated drinking water;
- Ingestion of contaminated soil;

- Ingestion of contaminated fish and shell fish;
- Ingestion of contaminated fruits and vegetables;
- Ingestion of contaminated meat, eggs, and dairy products;
- Ingestion of contaminated surface water while swimming;
- Dermal contact with chemicals in water;
- Dermal contact with chemicals in soil;
- Inhalation of airborne compounds (vapor phase or particulate), and;
- External exposure to penetrating radiation (immersion in contaminated air; immersion in contaminated water and exposure from ground surfaces with photon-emitting radionuclides).

Based on the location of the SNL ER sites and the characteristics of the surface and subsurface at the sites, we have evaluated these potential exposure routes for different land use scenarios to determine which should be considered in risk assessment analyses (the last exposure route is pertinent to radionuclides only). At SNL/NM ER sites, there does not presently occur any consumption of fish, shell fish, fruits, vegetables, meat, eggs, or dairy products that originate on-site. Additionally, no potential for swimming in surface water is present due to the high-desert environmental conditions. As documented in the RESRAD computer code manual (ANL, 1993), risks resulting from immersion in contaminated air or water are not significant compared to risks from other radiation exposure routes.

For the industrial and recreational land use scenarios, SNL/NM ER has therefore excluded the following four potential exposure routes from further risk assessment evaluations at any SNL/NM ER site:

- Ingestion of contaminated fish and shell fish;
- Ingestion of contaminated fruits and vegetables;
- Ingestion of contaminated meat, eggs, and dairy products; and
- Ingestion of contaminated surface water while swimming.

That part of the exposure pathway for radionuclides related to immersion in contaminated air or water is also eliminated.

For the residential land-use scenario, we will include ingestion of contaminated fruits and vegetables because of the potential for residential gardening.

Based on this evaluation, for future risk assessments, the exposure routes that will be considered are shown in Table 1. Dermal contact is included as a potential exposure pathway in all land use scenarios. However, the potential for dermal exposure to inorganics is not considered significant and will not be included. In general, the dermal exposure pathway is generally considered to not be significant relative to water ingestion and soil ingestion pathways but will be considered for organic components. Because of the lack of toxicological parameter values for this pathway, the inclusion of this exposure pathway into risk assessment calculations may not be possible and may be part of the uncertainty analysis for a site where dermal contact is potentially applicable.

Table 1. Exposure Pathways Considered for Various Land Use Scenarios

Industrial	Recreational	Residential
Ingestion of contaminated drinking water	Ingestion of contaminated drinking water	Ingestion of contaminated drinking water
Ingestion of contaminated soil	Ingestion of contaminated soil	Ingestion of contaminated soil
Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)
Dermal contact	Dermal contact	Dermal contact
External exposure to penetrating radiation from ground surfaces	External exposure to penetrating radiation from ground surfaces	Ingestion of fruits and vegetables
		External exposure to penetrating radiation from ground surfaces

EQUATIONS AND DEFAULT PARAMETER VALUES FOR IDENTIFIED EXPOSURE ROUTES

In general, SNL/NM expects that ingestion of compounds in drinking water and soil will be the more significant exposure routes for chemicals; external exposure to radiation may also be significant for radionuclides. All of the above routes will, however, be considered for their appropriate land use scenarios. The general equations for calculating potential intakes via these routes are shown below. The equations are from the Risk Assessment Guidance for Superfund (RAGS): Volume 1 (EPA, 1989a and 1991). These general equations also apply to calculating potential intakes for radionuclides. A more in-depth discussion of the equations used in performing radiological pathway analyses with the RESRAD code may be found in the RESRAD Manual (ANL, 1993). Also shown are the default values SNL/NM ER suggests for use in Reasonable Maximum Exposure (RME) risk assessment calculations for industrial, recreational, and residential scenarios, based on EPA and other governmental agency guidance. The pathways and values for chemical contaminants are discussed first, followed by those for radionuclide contaminants. RESRAD input parameters that are left as the default values provided with the code are not discussed. Further information relating to these parameters may be found in the RESRAD Manual (ANL, 1993).

Generic Equation for Calculation of Risk Parameter Values

The equation used to calculate the risk parameter values (i.e., Hazard Quotient/Index, excess cancer risk, or radiation total effective dose equivalent [dose]) is similar for all exposure pathways and is given by:

Risk (or Dose) = Intake x Toxicity Effect (either carcinogenic, noncarcinogenic, or radiological)

$$= C \times (CR \times EFD/BW/AT) \times \text{Toxicity Effect} \qquad (1)$$

where

- C = contaminant concentration (site specific);
- CR = contact rate for the exposure pathway;
- EFD = exposure frequency and duration;
- BW = body weight of average exposure individual;
- AT = time over which exposure is averaged.

The total risk/dose (either cancer risk or hazard index) is the sum of the risks/doses for all of the site-specific exposure pathways and contaminants.

The evaluation of the carcinogenic health hazard produces a quantitative estimate for excess cancer risk resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of the quantitative estimate with the potentially acceptable risk range of 10^{-4} to 10^{-6}. The evaluation of the noncarcinogenic health hazard produces a quantitative estimate (i.e., the Hazard Index) for the toxicity resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of this quantitative estimate with the EPA standard Hazard Index of unity (1). The evaluation of the health hazard due to radioactive compounds produces a quantitative estimate of doses resulting from the COCs present at the site.

The specific equations used for the individual exposure pathways can be found in RAGS (EPA, 1989) and the RESRAD Manual (ANL, 1993). Table 2 shows the default parameter values suggested for used by SNL at ER sites, based on the selected land use scenario. References are given at the end of the table indicating the source for the chosen parameter values. The intention of SNL is to use default values that are consistent with regulatory guidance and consistent with the RME approach. Therefore, the values chosen will, in general, provide a conservative estimate of the actual risk parameter. These parameter values are

Table 2. Default Parameter Values for Various Land Use Scenarios

Parameter	Industrial	Recreational	Residential
General Exposure Parameters			
Exposure frequency (d/y)	***	***	***
Exposure duration (y)	30[a,b]	30[a,b]	30[a,b]
Body weight (kg)	70[a,b]	56[a,b]	70 adult[a,b] 15 child
Averaging Time (days) for carcinogenic compounds (=70 y x 365 d/y) for noncarcinogenic compounds (=ED x 365 d/y)	25550[a] 10950	25550[a] 10950	25550[a] 10950
Soil Ingestion Pathway			
Ingestion rate	100 mg/d[c]	6.24 g/y[d]	114 mg-y/kg-d[a]
Inhalation Pathway			
Inhalation rate (m^3/yr)	5000[a,b]	146[d]	5475[a,b,d]
Volatilization factor (m^3/kg)	chemical specific	chemical specific	chemical specific
Particulate emission factor (m^3/kg)	1.32E9[a]	1.32E9[a]	1.32E9[a]
Water Ingestion Pathway			
Ingestion rate (L/d)	2[a,b]	2[a,b]	2[a,b]
Food Ingestion Pathway			
Ingestion rate (kg/yr)	NA	NA	138[b,d]
Fraction ingested	NA	NA	0.25[b,d]
Dermal Pathway			
Surface area in water (m^2)	2[b,e]	2[b,e]	2[b,e]
Surface area in soil (m^2)	0.53[b,e]	0.53[b,e]	0.53[b,e]
Permeability coefficient	chemical specific	chemical specific	chemical specific

*** The exposure frequencies for the land use scenarios are often integrated into the overall contact rate for specific exposure pathways. When not included, the exposure frequency for the industrial land use scenario is 8 h/d for 250 d/y; for the recreational land use, a value of 2 hr/wk for 52 wk/y is used (EPA, 1989b); for a residential land use, all contact rates are given per day for 350 d/y.

[a] RAGS, Vol 1, Part B (EPA, 1991).

[b] Exposure Factors Handbook (EPA, 1989b)

[c] EPA Region VI guidance.

[d] For radionuclides, RESRAD (ANL, 1993) is used for human health risk calculations; default parameters are consistent with RESRAD guidance.

[e] Dermal Exposure Assessment, 1992.

suggested for use for the various exposure pathways based on the assumption that a particular site has no unusual characteristics that contradict the default assumptions. For sites for which the assumptions are not valid, the parameter values will be modified and documented.

Summary

SNL proposes the described default exposure routes and parameter values for use in risk assessments at sites that have an industrial, recreational or residential future land-use scenario. There are no current residential land-use designations at SNL ER sites, but this scenario has been requested to be considered by the NMED. For sites designated as industrial or recreational land-use, SNL will provide risk parameter values based on a residential land-use scenario to indicate the effects of data uncertainty on risk value calculations or in order to potentially mitigate the need for institutional controls or restrictions on Sandia ER sites. The parameter values are based on EPA guidance and supplemented by information from other government sources. The values are generally consistent with those proposed by Los Alamos National Laboratory, with a few minor variations. If these exposure routes and parameters are acceptable, SNL will use them in risk assessments for all sites where the assumptions are consistent with site-specific conditions. All deviations will be documented.

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